POWER

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The Atom

WE USED to be taught that the atom was the ultimate, indivisible unit of matter. Molecules, composed of atoms, could be split up. Water, for instance, is composed of molecules each made up of two atoms of hydrogen and one of oxygen. It can be decomposed into its elements by breaking down the molecules, but the hydrogen and oxygen, consisting only of atoms, were elementary substances and could not be changed.

But recent researches indicate that the atoms themselves are composite bodies made up of protons and electrons, and that atoms of one supposed element may change to atoms of another by radiating or giving off some of their particles.

It is difficult to think of the massive and impenetrable materials that we handle and use as being, not solid continuous substances, but composed of myriads of these little planetary systems the constituent particles of which are separated by distances huge in comparison with their own diameters.

Sir William Bragg in a popular lecture said that if the target of an X-ray bulb were magnified until it was as great as the moon's disk—which would be about a hundred million times—the atoms in it would be a centimeter or so in diameter, but the electrons and protons would still be invisible to the naked eye.

In a recent lecture before the Engineers' Club at New York, Dr. F. W. Aston, of Cambridge, England, said that if the atoms in a cubic decimeter (less than four inches cubed) of lead could be placed in a straight line spaced only as far apart as they are in the metal, they would make a string 6.3 million million miles long; the distance that light, traveling at the rate of 186,000 miles a second, would take a year to pass through.

If one should pour a glass of water over Niagara Falls and then go away for a billion years or so until that glass of water had become thoroughly mixed up with all the other water in the world, and then should return and dip a glass of water out of the middle of the Atlantic ocean, how much chance, Dr. Aston asked, would he have of finding in it one of the atoms from the original glassful? He would get 2,000; for there are 2,000 times as many atoms in a glass of water as there are glasses of water in the world.

The amount of energy in a moving body increases as the square of its velocity, and the energy stored up in these minute planetary systems by reason of the number and velocity of their particles is astounding. "If," said Dr. Aston, "the hydrogen in 9 cubic centimeters of water could be changed to helium, there would be liberated 200,000 kilowatt-hours of energy. Somebody may discover some time how to make the conversion, but in doing so may set off a train of decomposition that would cause the record of his achievement to be written on the firmament in a new star."

F. R. Low

Oil Engine vs Steam Power

By

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ONE of the main topics of discussion among engineers is the heavy-oil engine and its economic position in connection with stationary power generation, particularly in competition with steam, and more particularly in connection with the smaller plants. As all know, the use of power in this country is rapidly increasing and the situation now is a total stationary power capacity somewhere over 50,000,000 hp. This means a great deal to the country, because it indirectly leads to the conclusion that the people are using themselves in other than muscular pursuits. In this great increase of power use we find that the proportions of different forms of power sources are not changing as rapidly as was anticipated, though there is some change. The figures are at present about like this: From steam, or through steam from fuel, about 61 per cent of the total output; water power about 25 per cent; and by internal-combustion engines about 14 per cent. This you must remember, is for stationary plants only and does not apply to the transportation field, where the internal-combustion engine is challenging the leadership of steam very effectively. To some people the knowledge that steam still supplies the large part of our power means that other competition is really not effective. This is not true, and the latest factor in this competition is the rise of the heavy-oil engine as a more active competitor than has yet appeared.

The heavy-oil engine has developed rapidly in recent years, and this rapidity of advance has hardly been noticed by engineers outside the field. That the heavy-oil engine is today a competitor against steam as it never was before, and that it is going to be more widely competitive in the future is acknowledged by all who are familiar with the power-plant field. The problem is to define when and where oil engines give cheaper power than steam or vice versa, to select and to determine on what sort of facts a selection of one or the other should be made.

*The basis of this discussion was an address by Dr. Lucke before the Textile Power Engineers, at Boston, Mass., which remarks have been elaborated upon in this paper.

The first of these factors tending to make the oil engine of importance is the increasing availability of fuel oil, which is, of course, the basis of any heavy-oil engine operation. All are familiar with the statistics of the growth of the automobile and related demands for gasoline. The gasoline demand controls the petroleum business today and bids fair to control it forever. For every gallon of gasoline made, taking the statistics for the United States as a whole, there remain behind two gallons of fuel oil residue. Therefore, we have in fuel oil available twice the volume of gasoline, and as gasoline demands increase, so will there be just twice as much more fuel oil available.

It may be said, then, that the automobile insures a supply of fuel oil that is today not utilized efficiently, because the bulk is burned under boilers or in heat-creating furnaces. That is one of the contributing factors to the increased competitiveness of the heavy-oil engine, which by reason of its higher efficiency can afford to burn fuel at higher prices than is possible in boilers where it competes with coal, so that in time the oil engine will outbid the steam boiler and take to itself the whole available supply of fuel oil.

The other factor is the matter of plant size. Any reader of the papers in the engineering journals and society transactions on power and the advances in generating power, cannot help being struck with the stress laid upon the big plant. Just as soon as a turbine of 25,000 kw. is put to work, every journal features the story, and very properly. The stories are repeated with an increase in size to 35,000 and 45,000 and so on. This sort of thing fills the reading public with a proper sense of admiration for units and plants of great magnitude, but it also leads improperly to a feeling of indifference toward small units and small plants. The number of big plants in the country can never be large, and they affect only those districts where the population is dense. It is now understood that industrially the important power problem is a matter of hundreds of horsepower per installation rather than one of tens of thousands. That being the case, the oil engine becomes

more and more important because it is most competitive in the smaller sizes. The reason the heavy-oil engine is more competitive in the smaller sizes is very simple, so simple that it is surprising to find it so little understood, though it has been known for years.

Efficiency of Small Oil Engines

The internal-combustion engine of all kinds, and including of course the small sizes of heavy-oil engine, is practically as efficient as the large units, whereas such is not at all the case with steam. Also the efficiency of the internal-combustion engine of the heavy-oil type is always much higher than the corresponding capacity steam plants. The relation may be stated in this way: The most elaborate steam plant, with all the heat-saving devices that ingenuity and thermodynamics can suggest, is still not as efficient as what one would call a poor heavy-oil engine. It is a matter of fact, statistical and easily verified, that in a small plant within the ranges of size under discussion, say less than 500 kw., the efficiency of the steam plant is from 1 to a maximum of 8 per cent, while the corresponding efficiency for the heavy-oil engine will never be less than 25 per cent and for good ones, properly located, over 30 per cent. Here is the main reason for the increased competitive strength of the heavy-oil engine against the steam plant.

All these things together justify the conclusion that no one today dealing with power, especially for small

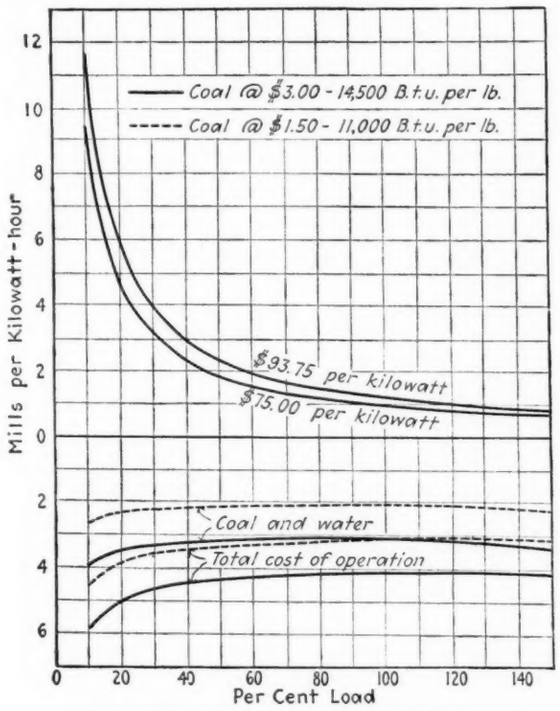


FIG. 1. COST OF STEAM POWER

plants, can sweep aside the heavy-oil engine in favor of steam. The figures of power costs must be carefully worked out to decide whether a given case is in favor of steam or of the oil engine.

With this general statement the question involved may be analyzed. The first question is concerned with the factors of power cost, or cost competition; the second with the heavy-oil engine itself and the things that have happened to justify the statement that it is easier to attend, easier to maintain, more reliable and capable of cheaper power cost than it used to be and available in small sizes.

The cost question is, of course, a very long and detailed one to analyze exhaustively, but the fact is that one need not deal with every element of it in detail. One can get a fairly good picture of the situation by examining a few of the leading or controlling points and omitting the rest, or by judging the situation in

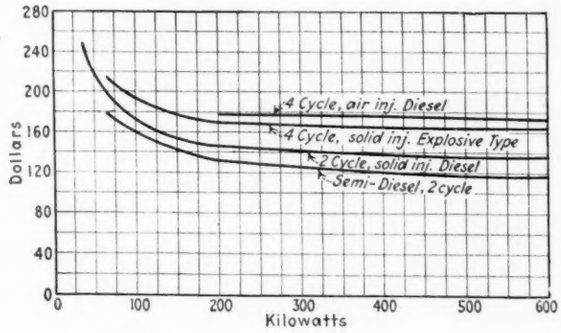


FIG. 2. INITIAL COST OF OIL-ENGINE PLANT

generalities, being careful not to be so general that conclusions lose all value.

The first generality justified in this connection is as follows: The competition or the dividing line between the situation that favors steam on the one hand, and that which favors the oil engine on the other, is a *size* matter—the size of installation and the size of engine. For every power plant in this country, wherever it may be, there is some size below which the oil engine would generate cheaper power and above which steam power would be cheaper. Perhaps the size in one case may be below 100 hp. for the oil engine and above 100 hp. for steam, or the dividing line may be set at 5,000. No one can tell offhand. The question must be decided by studying the factors of the local conditions to find the size separating the zone of the oil engine from that of steam.

Comparative Fuel Costs

In the matter of working out the values of the elements of cost that fix the size zones, what are going to be the main quantities? Probably the controlling quantities are the price that one must pay for heat in fuel and the efficiencies of the plants. Fuel prices should be in cents per million B.t.u. in whatever form it may be bought, coal or oil; and not so much price in the absolute sense of cents per million B.t.u. as in the relative sense of the ratio of the price of fuel oil to the price of coal, each measured in cents per million B.t.u. Fuel prices or price ratios are not conclusive because the efficiency of utilization of heat is very different for oil engines against steam. Taking the higher efficiency for a small steam plant of 8 per cent and the lowest efficiency of the oil engine as 24 per cent, then their efficiency ratio is 3 to 1. Taking the lowest steam-plant efficiency at 1 per cent and the highest conservative efficiency for the oil engine as 30 per cent, there is an efficiency ratio of 30 to 1. So the efficiency ratio may be said in these small plants to range from a minimum of 8 to 1 to a maximum of 30 to 1, always in favor of the oil engine. It is clear from this that for equal cost per kilowatt-hour the price for fuel may be

much higher in the form of oil for an oil engine than for oil or coal for a steam plant. Oil-engine fuel prices may be from 30 times as much to 8 times as much as fuel prices for steam plants and still yield an equal fuel cost per kilowatt-hour. If fuel oil for the oil engine can be bought for something less than these figures, then the fuel cost for oil-engine power will be just so much cheaper than for steam power.

To summarize up to this point: The deciding factor in oil-engine competition with steam will be size, and the size that divides one zone from the other will depend mainly on the two ratios—first the fuel-oil cost to the coal cost, and second, their efficiencies, which together fix the ratio of the oil engine fuel cost to the steam-plant fuel cost per kilowatt-hour.

There are, of course, other factors in this competitive cost situation, such as attendance, maintenance and miscellaneous supplies. These items must each be examined, and their relative values for oil compared to steam power may shift the balance of lesser power cost from one to the other. But even without examining them it may be found, and quite often will be found, that the item of fuel cost per kilowatt-hour, being the largest single one, except fixed charges, will tell right off, by applying relative thermal fuel efficiencies to the relative prices of fuel, whether oil engine or steam will give cheaper power. This is so easily done that it is a useful preliminary step to see how nearly equal are the two alternatives as to cost of power. The really proper orderly procedure requires that fixed charges be evaluated for both oil engine and steam before undertaking to compare fuel costs per kilowatt-hour. The matter of fixed charges is very simple to work up. It isn't a matter of statistics at all, nor a matter of opinion, but rather one of simple arithmetic. If the fixed charges are determined and then the operating charges per kilowatt-hour, the total power cost per kilowatt-hour can be beautifully illustrated by the sort of curves H. C. Stott showed in his paper entitled, "Notes on the Cost of Power," presented before the Institute of Electrical Engineers Dec. 18, 1908. From the paper one curve sheet is reproduced in Fig. 1, this being for a large steam-turbine plant. The curve is a graphical power cost sheet with the fixed charges above zero and the operating charges shown below the zero line, horizontal distances representing the ratio of average load to maximum installed capacity. Stott showed that the fixed charges would be represented by a curve that is really a rectangular hyperbola because the product of per cent load and fixed charges per kilowatt-hour is proportional to the fixed sum per year charged against power and representing the investment.

Investment in plant per kilowatt of installed capacity can be pretty well estimated from time to time by prevailing equipment prices. Plotting dollars of cost of complete electric generating plant per kilowatt of capacity vertically and the kilowatt capacity horizontally as in Fig. 2, it will be found that small plants cost more per kilowatt than large plants, but there is a tendency for cost per kilowatt to become constant when a certain capacity is reached. The curves of Fig. 2, for plants from 30 kw. to 600 kw., have recently been drawn and represent present prices for four types of different oil-engine plants, including building foundations, piping and everything complete as the purchaser would have to pay for it. The highest costs are for the four-stroke-cycle air-injection Diesel engines; next, for the four-stroke-cycle solid-injection explosive engine; third, for the two-stroke-cycle solid-injection Diesel engine; and the cheapest is the two-stroke-cycle surface ignition or semi-Diesel engine. There is a distinct rise in the curves in the smaller powers and a definite tendency to straighten out as capacity increases. The same would be true of steam plants, but in general the steam-plant first costs would be always lower than the oil-engine costs.

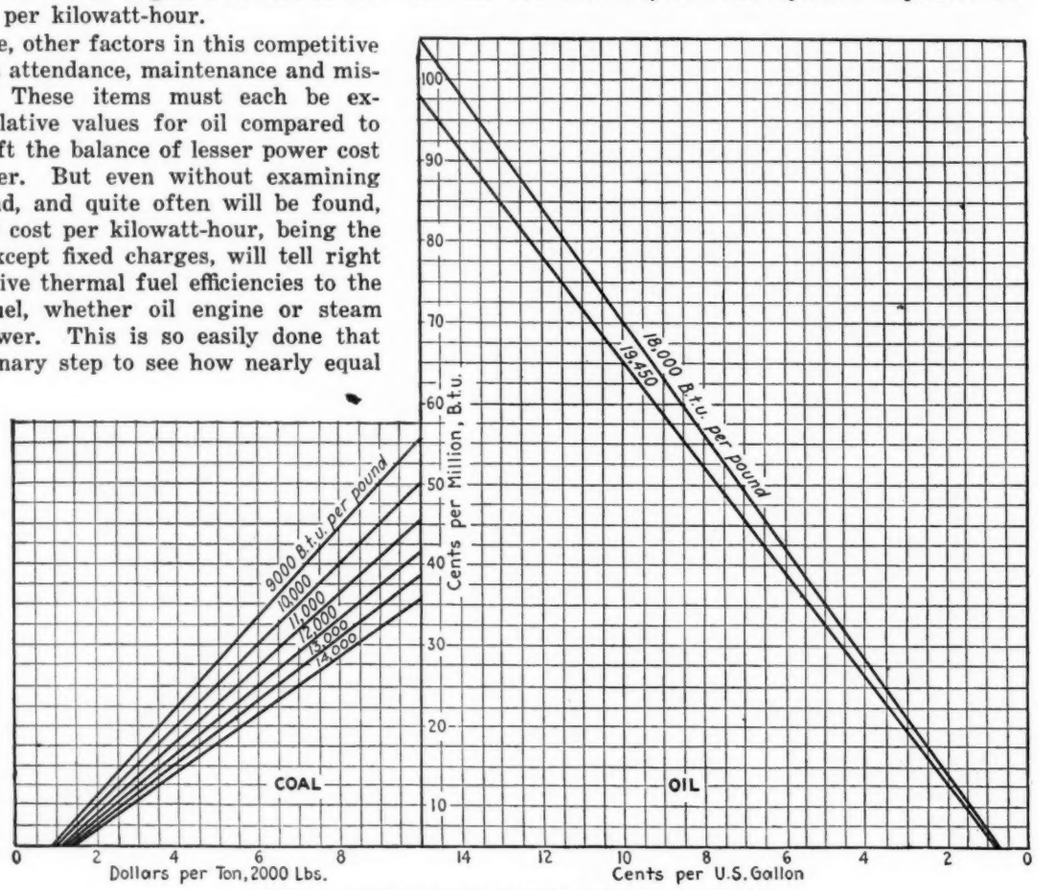


FIG. 3. COMPARATIVE COST OF COAL AND OIL

The important thing, however, is not absolute value of the investment per kilowatt shown by either set of curves, but the relative position of them, oil engine to steam. The relative position is such as to indicate an oil-engine plant costs more than the steam per kilowatt to install, the difference being less in the small sizes than in the larger sizes. Therefore it is clear that the oil-engine plant starts off with a fixed charge power cost handicap, and the oil engine can compete successfully with steam only when its operating charges are considerably less—enough to more than equalize the fixed

charge excess. Unless the operating charges of the oil engine are enough less than the steam plant of the same capacity, the oil engine cannot compete with steam.

Whether the fuel cost of operating with oil, or the fuel-cost item of the total operating cost, will be more or less than steam depends first on the fuel price ratio and then on the efficiency ratio. In Fig. 3 is shown a chart for working out such B.t.u. price ratio for coal or oil of any calorific power and price per ton or per gallon. On the vertical axis is a scale of cents per million B.t.u.

Coal and Oil Costs

As an example of use, suppose coal cost $6 per ton and had a calorific value of, say, 12,000 B.t.u. In that case the coal fuel cost according to the chart would be 25c. per million B.t.u. Passing across the chart to 18,000 B.t.u. oil, it appears that its equivalent price would be 3.5c. per gallon. Now if the efficiencies of the oil engine and the steam plant were 5 to 1, then with these relative fuel prices the steam-plant fuel cost per kilowatt-hour would be five times that for the oil engine, or 2½ times if the coal were $3 a ton instead of $6 with the same fuel oil.

If the fuel costs per kilowatt-hour were plotted on a Stott curve and the efficiency variation with load taken into account, the curve would be fairly flat like that in Fig. 1 for both the oil engine and the steam plant. Whenever the differences in fuel-oil costs per kilowatt-hour, oil engine versus steam, were such as to make up the difference between fixed charges or more than make it up, then without evaluating labor and without evaluating maintenance it would be a pretty just but preliminary conclusion to assume that the oil engine would generate power cheaper than the steam plant. Sometimes the conclusion at this point is so clearly in favor of one or the other that it isn't worth while to go further with the other items. In cases, however, where the values are pretty close and where the money saved in fuel per kilowatt-hour by the oil engine just about balances the difference in fixed charges over steam, then it is surely necessary to go further and examine the relative labor and maintenance costs per kilowatt-hour, and it is between them that the deciding factor may be found.

Saving in Labor Charges

On the matter of labor per kilowatt-hour attention is invited to this fact: Starting with a very small engine, say 50 kw., it is clear than one man could take care of it. It is also clear that the man would not be very busy. He could do something else, and a part of his time could be charged against that other thing. This is perfectly possible in lots of cases. As size increases, a point will be reached where the one man will be fully occupied and beyond which he will need help part of the time of a second man. This may be at 200 kw. and possibly more. The horsepower at which the second man becomes necessary will always be smaller for a steam plant than for an oil engine. There is much more for a man to do about a steam plant than there is for him to do about an oil-engine plant of equal capacity. There is no case except with a very obsolete form of the oil engine where the labor cost per kilowatt-hour could ever be more with the oil engine than with the steam plant. Also, with the steam plant, if it were a one-man plant, then by the law of many states that one man must not leave the plant because there is a steam boiler in it, and a steam boiler is regarded as unsafe, requiring constant attendance whether there is anything to do or not. On the other hand, the oil engine may be left and do no harm. So on the question of relative labor the labor per kilowatt-hour for the oil engine will be equal to or less than for the steam plant. It cannot be more.

On the item of maintenance per kilowatt-hour little help toward a conclusion is possible by reasoning, for maintenance costs are facts, matters of history. One never knows what they are until the bills are paid. Who knows when a boiler tube is going to burn out or a cylinder head crack and what incidental damage may result? Everything depends on the design, the attendance and local service conditions.

It is true, however, that on the matter of maintenance-cost statistics it is possible to draw one conclusion, and a pretty important one, that the maintenance costs for oil-engine plants are at least competitive with those for steam plants. No accurate general reports on power-plant costs are published in this country, but the English Reports of Electrical Undertakings, which are required by law to be made on standardized forms under oath, clearly demonstrate that the costs of maintenance are competitive and that the costs of labor are also competitive for oil engines compared with steam plant and others of mixed type.

Comparison of Total Charges

The conclusions so far reached may be summarized as follows: First, the fixed charges will always be greater for the oil engine than for the steam plant, and how much greater depends on size. The difference is greater for big than for small plants; in other words, small plants are more nearly equal in first cost. Secondly, the fuel charges depend upon the relative efficiencies and on the ratio of fuel prices in the form of oil for the oil engine to fuel prices in the form of coal for the steam plant, and for each section of the country and every size of plant the dividing line is about where the fuel cost per kilowatt-hour saved by oil engine over the steam plant will just balance the fixed charges. Below this size the tentative conclusion generally is that the smaller plants give cheaper power with oil engines, but this cannot be accepted as final until checked by inclusion of the labor and maintenance costs per kilowatt-hour. When the total figures are found, a just conclusion may be reached. In any case, anywhere, at any time, there is some size of plant that divides the small power zone which belongs to the oil engine from the larger power zone which is steam territory. Our problem as engineers is to recognize these facts, develop data that will enable anyone to decide when and where the job in question is an oil engine job and when a steam job, whether the size is above the dividing zone or below it. As this information is developed and as it accumulates and is given publicity by the engineering publications in meetings of engineers, so will the small power problem come nearer a satisfactory solution than it now is.

In some sections of the country they have already recognized the advantage of the oil engine for small plants and have acted on it. There are sections in the West, beyond the Mississippi, where the price ratio conditions are favorable and where the power demands for towns or local industries are small, and where at this moment there are thousands of oil-engine plants in operation.

Operating Two Direct-Current Stations in Parallel

Method of Locating the Cause of Two Direct-Current Plants Giving Trouble When Operated in Parallel and How This Trouble Was Overcome

By G. F. WHITE

TWO 500-kw. 220-volt direct-current engine-driven generators supplied current to a load approximately 1,500 ft. away. A load of 200 to 500 amperes was supplied at the generating station itself. As the load increased to such an amount as to overload the generators, it was decided to install another generating unit. This unit was placed at the distributing point 1,500 ft. away from the original machines and was turbine-driven on account of a large amount of exhaust steam available at that point.

In laying plans for this machine, the manufacturer sent a representative to investigate conditions, and it was reported that since the voltage was practically constant at the distributing point, which was 1,500 ft. away from the engine-driven station, no equalizing would be necessary, and that the new generating unit should be practically flat-compounded. When this machine was installed and started up, it was found that multiple operation was satisfactory sometimes for several days, but that under certain conditions the circuit breakers would open, making it necessary to parallel all over again.

This matter was looked into in order to find an explanation. The engine generators were found to be of an old design containing plenty of copper, with almost a straight line of voltage increasing from no load to full load (Fig. 1) and with an overload capacity of approximately 50 per cent. On the other hand, the turbine

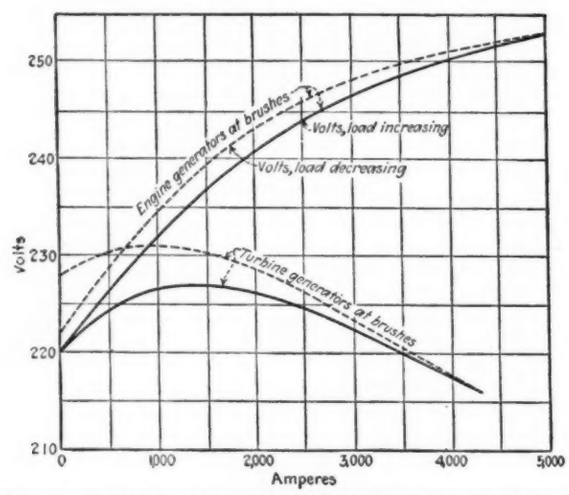


FIG. 1. ENGINE AND TURBINE VOLTAGE CURVES AT GENERATOR BRUSHES

unit, which consisted of two generators on the same shaft, had a more peaked curve of voltage so that there was a comparatively large rise of voltage at light loads, followed by an equal drop to the full-load point. It was noticed that the breakers opened when the load dropped suddenly to a small value. This was therefore attributed to the turbine unit producing a higher voltage than the engine unit when the load was removed. This would tend to cause the engine generators to run as motors on account of their voltage being lower. Under this condition the series-field current would reverse, and this would buck the shunt field and cause

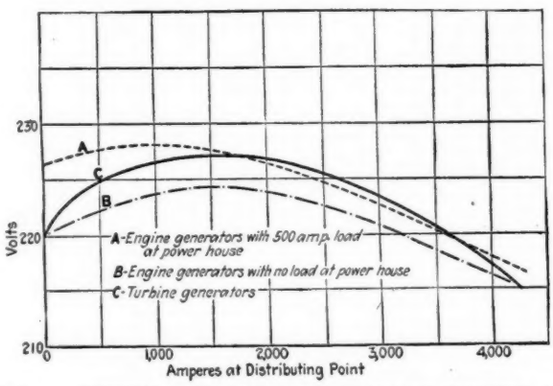


FIG. 2. ENGINE AND TURBINE VOLTAGE CURVES AT TURBINE GENERATOR BUSBARS

more current to be drawn, so that the action would continue until the breakers would open at both stations. It was necessary to correct the polarity of one or both of the engine-driven generators after such an occurrence, since the reversed current caused the magnetism to be reversed by the action of the series field.

It was also noted that when the engine generators supplied 4,000 amperes at the distributing point, the drop of voltage over the line was approximately 30 volts. With such a high line drop it did not seem possible that the engine generators would have serious trouble by being motorized.

Fig. 1 shows the engine-generator voltage curve at the brushes, with rising load indicated by the solid line and falling load indicated by the dotted line. The turbine-generator voltage curve is also shown with the voltage taken at the brushes. These curves were not taken with great accuracy, but illustrate only the general conditions. It was not practicable to take the curves with decreasing load, but some of these points were taken as the station load permitted. It can be seen why the turbine generator could be expected to produce more voltage than the engine generator when the load fell to a low value.

The solid-line curve *C* (Fig. 2) shows the turbine generator's voltage at the machine's busbars, when the load is increasing. The broken line curves, *A* and *B*, indicate the voltage of the engine generators at the turbine-generator's busbars. When no load is supplied near the engine generators, the dot-and-dash curve *B* represents this voltage, while if 500 amperes is being supplied at the engine house, the upper dotted curve represents the voltage produced at the distributing point. Multiple operation under such conditions should

be stable, since the effect of line resistance makes the engine-driven generator voltage curves practically the same as the turbine unit at the load, so that equalizing would not seem necessary. This resistance would allow only a small change in current in order to equalize the voltages. The curves show "under-compound" at overloads.

In looking for further cause of the trouble, it was noticed that when a heavy load occurred the turbine generators took approximately 3,000 amperes and the engine generators from 2,000 to 3,000 amperes, depending on the load. When this load was suddenly reduced to about one-quarter of this value, the turbine generator would tend to speed up above normal, while the engine generators remained below normal speed. This was caused by the turbine governor, which had to operate from extreme overload position to a small valve opening, while the engine governors were below the position of normal load or approximately three-quarter normal load. The turbine governor, therefore, had about twice the relative travel in order to govern at the remaining load, as did the engine governor. This made the turbine overspeed and caused an excessively high voltage, which was the seat of the trouble.

In order to make proper multiple operation, it was considered necessary to equalize the two stations. The turbine generators had a small drop of voltage across the series field, while the engine generators had a fairly large drop across their series field, and in addition there was the resistance of the line between the two stations to be considered. For proper operation it was necessary to have the voltage drop from the armature through the series field to the busbar at the distributing point equal on both turbine and engine

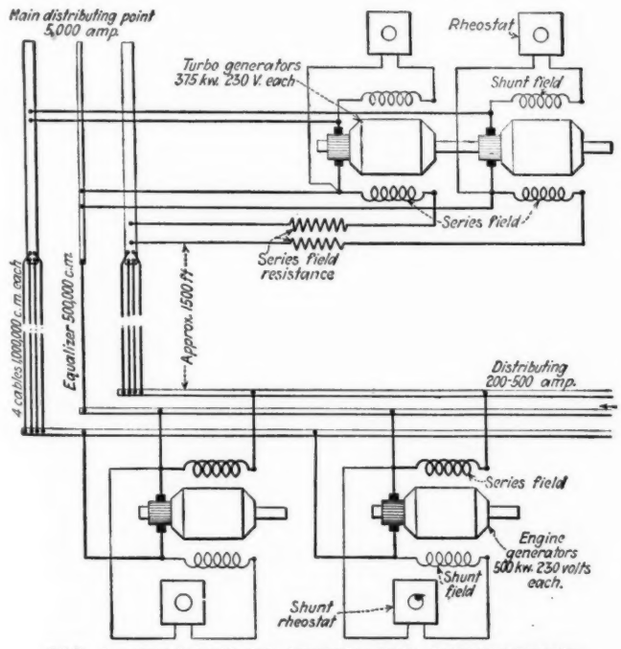


FIG. 3. DIAGRAM OF GENERATOR CONNECTIONS

generators. It was found that when the engine units delivered 4,000 amperes at the distributing point, the drop of potential from the negative brush to the negative busbar at the distributing point was about 20 volts. Under maximum conditions it was assumed that the engine generators would deliver 2,000 amperes at the distributing point with 10 volts drop and the turbine generator 2,000 amperes. The resistance for the turbine generator's negative lead from brush to busbar, including the series field, must therefore equal 10 volts in order to equal the drop of potential of the engine generators at 2,000 amperes from negative brush to negative busbar at the distributing point. The resistance of the leads were so adjusted, and an equalizer of 500,000 circ. mils connected in (Fig. 3), which made the operation satisfactory.

The widely varying load was produced by a number of heavy cranes and also a number of large motors that were operated at short intervals. The compound of the engine generators and line drop, together with the voltage at the distributing point, can be seen from the table.

GENERATOR VOLTAGES AND VOLTS DROP IN LINE

Total Load, Amperes	Volts at Brushes	Voltage Drop Series Field Negative Line	Voltage Drop Positive Line	Total Drop	Volts at Distributing Point No Load Eng. Hse.	Volts at Distributing Point 500 Amp. Eng. Hse.
0	220	0	0	0	220	226
1,000	232	5	3¾	8¾	223¼	227
2,000	241	10	7½	17½	223½	226
3,000	247	15	11¼	26¼	220¾	222
4,000	250	20	15	35	215	216¼
5,000	253	25	18¾	43¾	209¼	....

Arrangements were made so that when the load was light enough to shut down one engine generator, two of the large cables on each side of the line could be disconnected in order to keep the line drop in proportion to the turbine resistance. Multiple operation, however, was so satisfactory that this was not considered necessary. Arrangements were also made for short-circuiting the series-field resistances on the turbine unit when this was operated alone.

The Brown Resistance Thermometer—How Such Instruments Work

Among the several different methods of measuring temperatures is one that depends upon the principle that the electrical resistance of most metals changes with their temperature. In carrying out this method, a suitable piece of metal is tested and its resistance is found for various temperatures; while still connected in an electrical circuit, it is placed in the furnace or wherever else it is desired to find the temperature, and then its temperature at any time may be calculated from its resistance. In practice instruments are calibrated so as to read directly in degrees of temperature instead of in resistance.

A customary method of measuring the resistance of the metal for such purposes depends on the familiar principle of the Wheatstone bridge, with which it is necessary to bring a galvanometer pointer to zero by adjustment of one or more auxiliary resistances before the resistance in question may be determined. This is unnecessary, however, in the so-called direct-reading resistance thermometer, which gives a direct reading without making it necessary to adjust the device for each change in temperature.

The resistance thermometer has an important advantage in that it may be adjusted so that its range covers only a small variation—say about 25 deg. F.—even at high temperatures, thus giving accurate results in cases where it is necessary to keep close track of a temperature within narrow limits. The Brown Instrument Co., of Philadelphia, Pa., manufacturer of several types of thermometers and pyrometers, has recently brought out a new direct-reading resistance thermom-

eter and recommends it for use in coal piles to warn of spontaneous combustion, in refrigerating rooms, in public buildings and schools, and in hydro-electric plants (for showing the approach of frazil or anchor ice temperatures). The indicating part of the instrument is shown in Fig. 1.

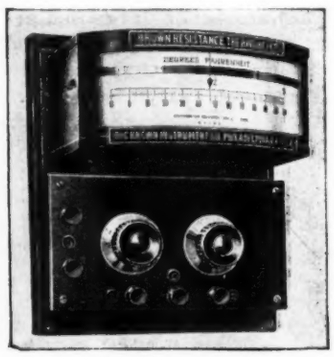


FIG. 1. THE NEW BROWN RESISTANCE THERMOMETER

In considering the action of such an instrument, it is necessary to review the important principle of the Wheatstone bridge. A conventional bridge circuit is shown at the top in Fig. 2. Current from the battery divides at the point *A* and flows through the two "arms" of the bridge. Assuming, for simplicity, that the resistance in one arm is 6 ohms and in the other 3 ohms and the voltage of the battery is 12, the current flowing through *AC* would be $\frac{12}{6} = 2$ amperes, and in *AD* it would be $\frac{12}{3} = 4$ amperes. Thus it will be seen that the currents in the two arms are inversely proportional to the resistances. This inverse proportion is always maintained between the two arms of a divided circuit. Therefore, unless the resistances in the two remaining arms *CB* and *DB* have the same proportion as in *AC* and *AD*, there will have to be a change in the proportion between the current flowing through *CB* and that flowing through *DB*. In such a case current will flow one way or the other between *C* and *D* through the galvanometer, thus deflecting the pointer. If, however, the same proportion between resistances is maintained in *CB* and *DB*, then no current will flow between *C* and *D*, and the galvanometer pointer will remain at zero.

If an unknown resistance is put in the arm *DB*, as at *E*, and a variable resistance in the arm *CB*, consisting of a rheostat, the resistance in *CB* may then be adjusted until the galvanometer pointer stands at zero, showing that no current is flowing between *C* and *D*, and under such conditions it is obvious that the proportion between the resistances in *CB* and *DB* is the same as between *AC* and *AD*.

Since the resistances of *AC*, *AD* and *CB* are known, the unknown resistance may be readily found by calculation. In the case of the thermometer the resistances in *AC* and *AD* are made equal, so that when the galvanometer shows zero the reading of the rheostat in *CB* indicates directly the resistance of the testing coil.

The latter may be, of course, some distance from the bridge itself. Such an arrangement requires a considerable length of wire between the coil and the bridge, and therefore introduces a possible error, because the resistance in the leads from the coil changes according to their temperature, and so makes the resistance of the arm *DB* greater or less than it ought to be to show accurately the temperature of the coil. An arrangement of "compensating leads" is therefore used, as shown in the second diagram in the illustration.

This arrangement consists simply in bringing the point *B* of the bridge circuit all the way out to the coil, so that the two leads, instead of being part of one arm of the bridge, are separated, and one is in the arm *DB* and the other in *CB*. This neutralizes changes in temperature and resistance in the two leads, since the addition of an equal resistance to each of the two equal arms does not affect the ratio between them.

Thermometers based on these first two diagrams are said to be of the "zero" type, because they do not give a reading until a pointer is brought to zero by adjustment of a resistance. The diagram for the "direct reading" thermometer is shown at the bottom. This method consists simply in calibrating the galvanometer, so that it indicates directly the resistance, and therefore the temperature, of the testing coil at a certain voltage. The battery voltage, therefore, must be kept constant, and this is done by taking the rheostat out of the bridge circuit and putting it into the battery circuit, and replacing it with a fixed resistance. As the battery grows weaker, the rheostat may then be adjusted to decrease the resistance and thus maintain a constant voltage on the bridge. In order to test the battery a two-pole switch is put in the arm *DB* so as to shunt a fixed resistance across the testing coil. This resistance

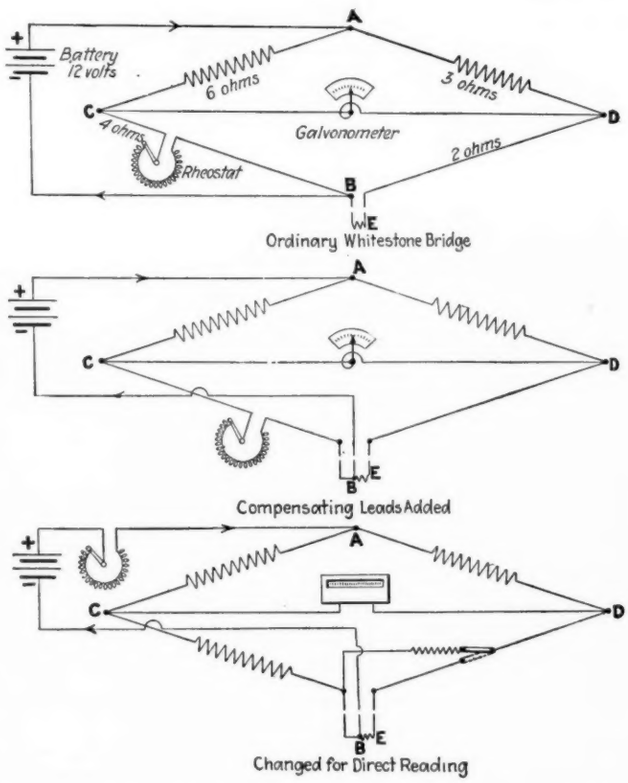


FIG. 2. HOW THE WHEATSTONE BRIDGE IS USED IN THE DIRECT-READING RESISTANCE THERMOMETER

The principle of the Wheatstone bridge, which is quite simple, may be followed through these diagrams to its application to thermometers.

is supposed to be the same as that of the coil when the latter is cold. When the coil is cut out and this resistance is in circuit, the rheostat is adjusted until the galvanometer gives the correct reading for the standard resistance, and then, when the coil is put into the circuit, its temperature is indicated directly. This testing of the battery current need not be done oftener than every few days, or at most every day.

Traveling Screens Perform Under Severe Conditions

By F. C. RUTLEDGE
Assistant Engineer, Union Gas and Electric Company, Cincinnati

LARGEST traveling screens in the world withstand a deluge of leaves and larger debris from the Ohio River pressed into heavy mats five inches to seven inches deep. During the emergency the screens proved their value, and afterward continued to function as satisfactorily as ever.

THE large traveling screens installed at the West End power plant of the Union Gas and Electric Co. at Cincinnati, recently underwent a severe test of their ability to keep out foreign material from the condensers. A description of the incident may prove of general interest, but first a brief outline of the plant itself will help in an understanding of the conditions obtaining.

As may be remembered from a previous description, the plant is situated on the North bank of the Ohio River, a little south of the mouth of the Licking River, which is on the opposite side of the Ohio River. Owing to this fact and to the conformation of the Ohio River bed at this point, the current is so deflected that much of the débris is carried against the intake tunnel. This débris comprises leaves, twigs, straw, grasses, garbage, tree limbs and trunks, and even telephone and telegraph poles. Besides this the river carries a great amount of mud and sand in suspension and at this point has an extreme variation in level of 71 feet.

The intake tunnel is 25 ft. high by 10 ft. wide, and the bottom is a few feet below the bottom of the river bed. The tunnel extends 164 ft. from the outside of the power-plant building, terminating in midstream. The other end terminates in an intake well 60 ft. in diameter and 100 ft. in depth. The bottom of this well is 5.7 ft. below the floor of the intake tunnel, the well itself being within the plant and midway between the two condenser wells, each of which contains the complete condensing equipment for the two 30,000-kw. units located above the well.

Contrary to usual custom the intake tunnel has no grills nor screens, the entire cross-section being clear except for horizontal concrete braces between side walls. These braces are approximately ten feet above the tunnel floor. It was deemed advisable to omit all grills, as

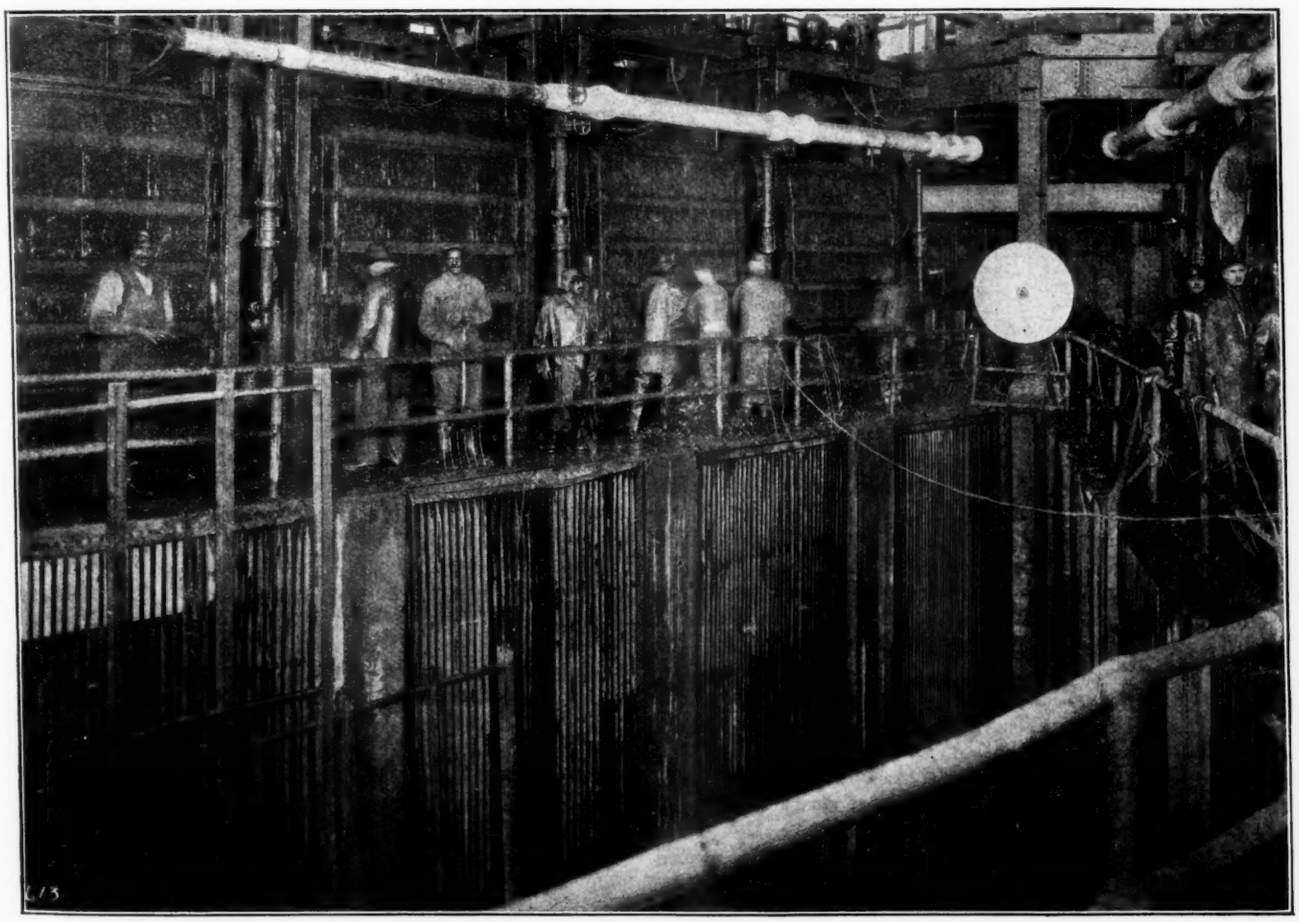


FIG. 1. THE SCREEN INSTALLATION AFTER THE WORST OF THE TROUBLE HAD PASSED

they might become clogged during a time of high water, when it would be utterly impossible to clean them. Consequently, all dependence was placed upon a series of stationary and traveling screens within the intake well itself, where river conditions could not prevent proper cleaning.

A good idea of the schematic arrangement of these screens may be obtained from the drawing, Fig. 2. It can be seen that the water passes first through a stationary grill, thence through two traveling screens in series and out through 54-in. pipes to the circulating pump suction.

Each machine, when in operation, requires 52,000 gal. of water per minute, or 104,000 gal. per condenser well, making a total of 208,000 gal. per min. through the tunnel. Such a tremendous volume of water carries an untold amount of débris when river conditions are bad.

In late fall or early spring, the rises that occur usually produce the most trying conditions, as the run-off carries the leaves that have fallen. The rush of water "mats" the soggy mass and makes its removal very difficult. The screens are provided with powerful jets of water, which are directed against the screens

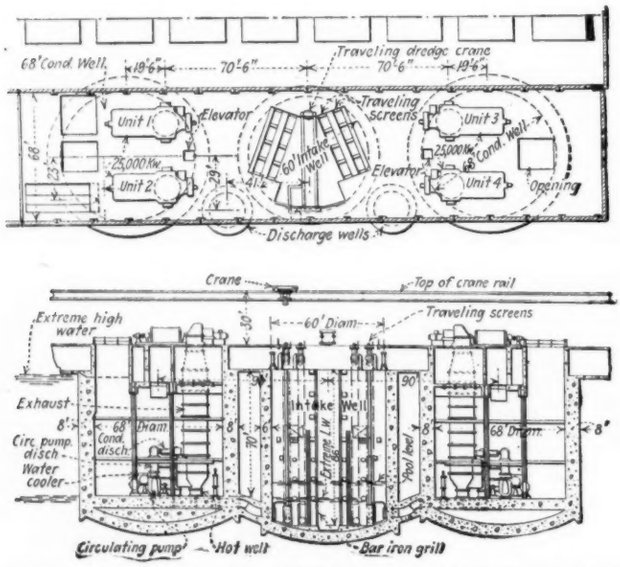


FIG. 2. GENERAL ARRANGEMENT OF CONDENSER AND INTAKE WELLS

from the inside as the buckets pass over the top rollers on their way down. Normally, these jets are sufficient to clear the screens of all débris.

About 3 a.m. Saturday, April 15, it was noticed that the amount of débris coming in was increasing rapidly, and although only one turbine was in operation at the time, the screens began to show enormous quantities of leaves and small twigs. With the coming on of the load, when it became necessary to cut in additional turbines, the difficulty increased and was further augmented owing to an ever-increasing amount of débris floating downstream. The baskets now came up covered with from 5 to 7 in. of leaves and twigs, firmly pressed into a heavy mat by the great pressure of water against the face of the screens. This applied to the outer screens, and the pressure of water naturally forced through the screen guides and around the bearings, a small amount of débris which was caught and removed by the second screens.

As the layer of leaves and twigs was so firmly pressed into the mesh and the mat itself was so thick that the jets were of no avail, it was necessary to call into service about twenty laborers, some of whom stood in front of the screens and pulled off the great bulk of the débris by hand, while others carted it away in wheelbarrows and dumped it into the discharge tunnel.

Fig. 1 gives an inadequate idea of the conditions with which the screens had to cope, as the worst of the trouble had passed before it was possible to get a photographer into the plant and the trouble gradually lessened during the day, owing partly to better river conditions and partly to the fact that only two machines are required to handle a Saturday afternoon load, which lessened the amount of water coming through the screens.

During this emergency the screens proved their worth and have given excellent satisfaction under regular operation. They are the largest of their kind in the country, being 91 ft. between centers, and were built by the Chain Belt Co., of Milwaukee.

Owing to the floor of the intake well being below the floor of the intake tunnel, a certain amount of wood, water-logged timbers, sand and other matter, collects in this pit. To remove it, a radial crane has been installed. This consists of a 5-ton crane, pivoted at one end and equipped with a grab bucket. The end of the crane opposite the pivot is equipped with wheels riding on a curved rail on the well wall. The span of this crane is 49 ft. 10 in. and the vertical lift of the grab bucket is about 100 ft. A bucket with a capacity of $\frac{3}{4}$ cu.yd. is used and it is equipped with special heavy teeth which enable it to grip tree trunks, logs and other heavy obstructions.

This crane is arranged to discharge over a hopper having an opening of 4 x 6 ft., which is large enough to permit the passage of the largest obstruction so far found in the well. The discharge side of the chute is so arranged that the débris is discharged into the Ohio River, below the intake, and consequently is carried by the current downstream and away from the power house.

A Common Error in Weighing Water

In testing boilers, pumps and other power-plant apparatus, it is frequently necessary to measure water by weighing it in a tank set on platform scales. In such cases care should be taken that the pipe supplying water to the tank does not project below the surface of the water, because that will result in erroneous readings. For example, in the arrangement shown in Fig. 1, if the tank is first weighed empty and then water is poured in with a pail to the level shown, the difference between the final gross weight and the original tare weight will be greater than the actual weight of the water poured in. The error will be greatest if the pipe is full of air at the start, and the valve closed so that water cannot run up into the pipe.

Before discussing further the case of the tank, it will be well to go back to a simple experiment illustrating the fundamental principle involved. This experiment is illustrated in Fig. 2. A glass vessel about two-thirds full of water is placed on the household scales shown at *A*, the total weight being 5 lb. *B* shows a cylinder of any non-porous material such as wood, aluminum or iron. It weighs 3 lb. in the air, as shown by the spring balance.

Now see what happens when the spring balance, with the weight attached, is carried over to the vessel of water and lowered until the cylinder is partly submerged. The buoyancy of the water makes the apparent weight of the cylinder go down. It is a well-known fact, which can easily be demonstrated by experiment,

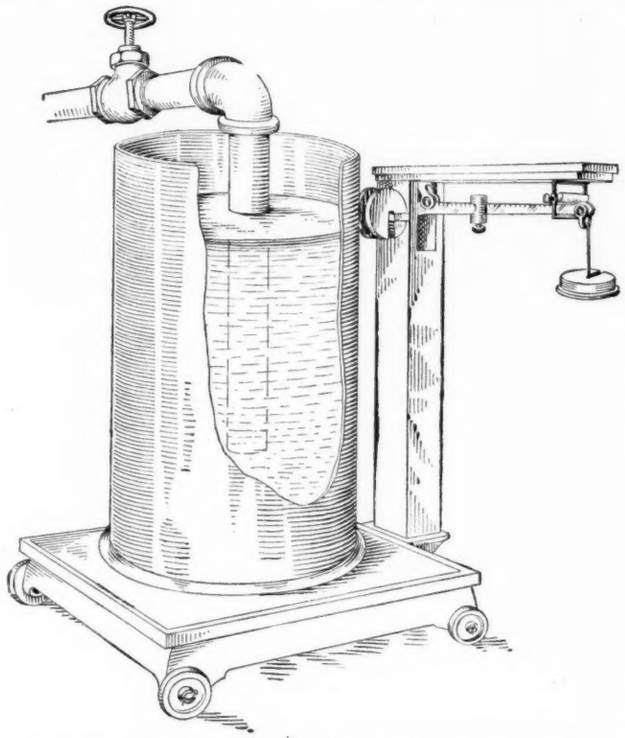


FIG. 1. DOES THE SUBMERGED DISCHARGE PIPE CHANGE THE APPARENT WEIGHT OF WATER?

that the loss of weight of any body partly or wholly submerged in water is equal to the weight of water displaced. Suppose that the cylinder is lowered until its weight decreases from 3 lb. to 2 lb. Its loss of weight is 1 lb. Therefore the weight of water displaced must be 1 lb. (The *volume* of water displaced is equal to the volume of the cylinder below the final level of the water.)

Now it is evident that the 1-lb. apparent loss in weight has not actually disappeared, but has merely been shifted from the upper scale to the water, which in turn must transmit it to the lower scale, so the lower scale must now read 6 lb. instead of 5.

The general rule may now be stated that when a solid object, externally supported, is pushed down into the water in a tank, without touching the tank, the apparent weight of the tank and the water it contains is increased by the weight of the water displaced.

Returning to Fig. 1, if the pipe is full of air and the valve open, and water is poured into the tank with a pail, the weight of water displaced by the discharge pipe will be rather small because the volume displaced will be only that of the actual metal below the surface of the water, since the water will be able to rise inside the pipe to the same level as outside. If, on the other hand, the valve is closed and the pipe full of air, then the water cannot rise appreciably inside the pipe and a large error will occur, amounting to about two pounds for every foot of 2-in. pipe.

Now suppose that the valve is closed, the tank empty and the pipe full of water under pressure as far as the valve. The empty weight is read and recorded as the tare. The valve is then opened, allowing water to run in. When it has risen to the level shown, the valve is shut off. If there are no air leaks between the valve and the open end of the pipe, that part of the pipe will be completely full of water. The weight recorded by the scale will be the original tare plus the weight of the water outside of the pipe, plus the weight of a cylinder of water having the same outside diameter as the pipe and a length equal to the distance the end of the pipe is submerged beneath the surface of the water. Another way of putting it is that the apparent net weight of water will be the same as if the level were where it is, but nothing were projecting beneath the surface.

It is not necessary to analyze this further, since the existence of an error has been definitely shown and since the error can easily be avoided by using a discharge nipple short enough to be above the surface of the water at all times.

There are, however, cases where it is necessary to submerge a pipe whose discharge contains steam that must be absorbed by colder water in the tank. In such cases error can be avoided by placing a union between the valve and the elbow. At each weighing the

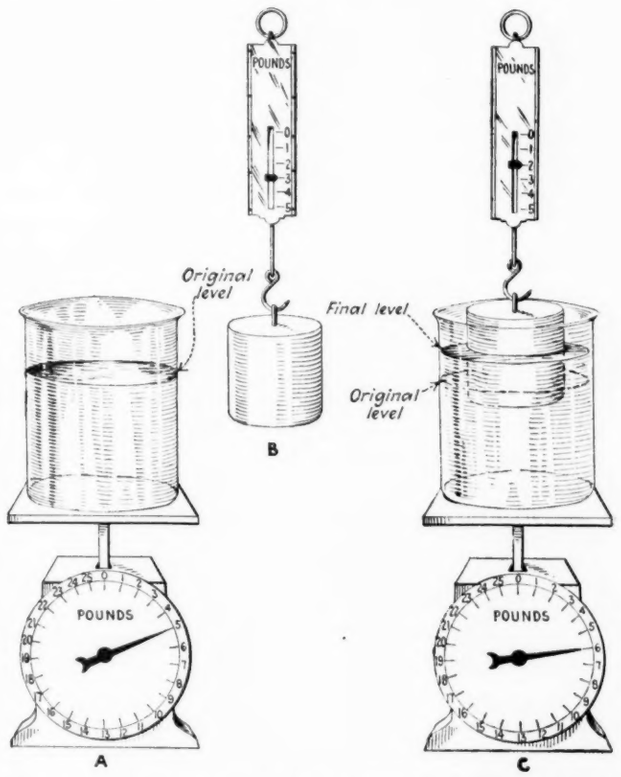


FIG. 2. EFFECT OF DIPPING A SOLID BODY INTO WATER.

A. Water and glass together weigh 5 lb. B. Solid cylinder weighs 3 lb. in the air. C. When cylinder is partly submerged it is buoyed up (or loses weight) by a force equal to the weight of water displaced. In this case the buoyancy amounts to 1 lb., so that the upper scale shows only 2 lb. The pound lost by the upper scale is added to the weight of the glass and water, making the lower scale read 6 lb. instead of 5 lb.

union is disconnected, thus allowing the piping beyond it to rest on the bottom of the tank. The scale will then register the correct total weight of tank, water and disconnected piping. In this way both the tare and the final weight are increased by the same amount, so that their difference is a true measure of the water and steam added.

City of Detroit Reduces Heating Cost

The old axiom, "The truest economy is in making the best use of that which you have," is well illustrated in the case of a group of municipal buildings in the City of Detroit. Formerly, these buildings for the most part were heated independently with small and uneconomical equipment requiring the services of a comparatively large number of men. Enlargement of the Receiving Hospital necessitated a change, and it was a question whether to install a new central heating plant or to remodel the best and largest of the plants already installed and heat all the buildings from this central source of supply. The latter plan was followed with gratifying results.

The group of buildings referred to, with the radiation and boilers, were as follows: The Municipal Court Building had 13,235 sq.ft. of direct radiation, 7,725 sq.ft. of indirect radiation and two 3,000-sq.ft. Heine boilers equipped with natural draft stokers. In the colder weather both boilers were used to heat the Court Building alone. The Receiving Hospital, containing 21,294 sq.ft. of direct radiation and 1,520 sq.ft. of indirect surface, received its supply of heating steam from two 1,000-sq.ft. Scotch boilers. The County Jail, with 6,500 sq.ft. of direct radiation, had two 40-in. x 10-ft., horizontal return-tubular boilers. With 1,547 sq.ft. of direct radiation, the Board of Health Building was supplied with steam by small return-tubular boilers, while the City Service Building, with 3,338 sq.ft. of direct radiation and the Central Fire Alarm Station containing 3,340 sq.ft. of direct radiation, were heated from an adjoining building. Thus this group of six buildings, containing a total of 49,254 sq.ft. of direct radiation and 9,245 sq.ft. of indirect surface, were supplied with steam from five different sources.

With the enlargement of the Receiving Hospital it was found necessary to remove the Scotch boilers and make some other arrangements for the heating of this building, and at the same time it was deemed advisable to arrange for the central heating of the entire group.

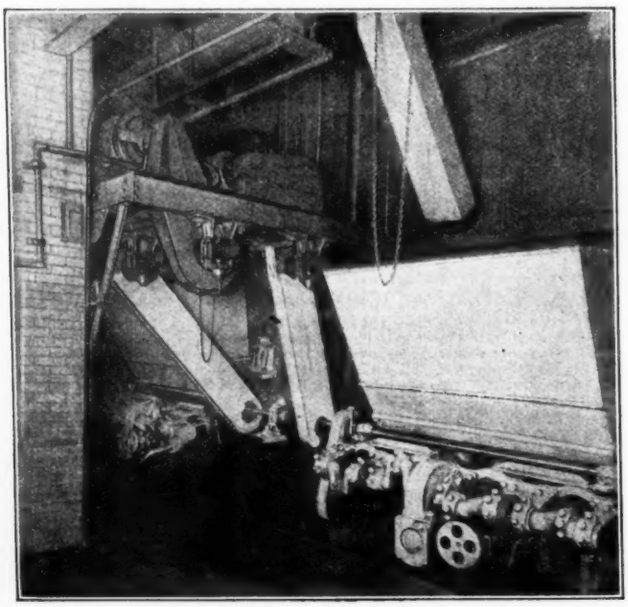


FIG. 1. THE NEW UNDERFEED STOKER INSTALLATION

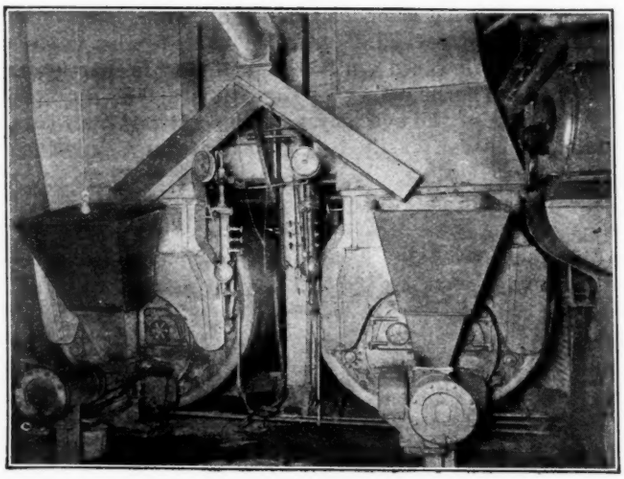


FIG. 2. SMALL SCOTCH BOILERS SUPPLYING LAUNDRY STEAM

The plan first conceived was to erect a new heating plant on ground east of the hospital, this being the only available space for such a purpose. With due consideration this location was considered too desirable for a heating plant, and the estimated cost ranged from $300,000 to $510,000. The solution was to remodel the plant in the Municipal Court Building, which contained the two 3,000-sq.ft. water-tube boilers. The old stokers were removed and four-retort Taylor underfeed stokers put in their place. A monorail coal-handling system leading from the storage bunker under the sidewalk to the boiler fronts was installed, and the plant was fitted with a CO_2 recorder and other instruments that would be of assistance in maintaining economical operation. Motors for driving the stokers were mounted overhead, as indicated in Fig. 2. In addition, the two 1,000-sq.ft. Scotch boilers from the Receiving Hospital were installed in this plant.

During last winter, with zero weather, only one of the 3,000-sq.ft. boilers was needed for the satisfactory heating of the entire group of buildings. Occasionally, the boiler reached 200 per cent of rating for short periods. Steam was supplied at 45-lb. pressure. One of the Scotch boilers was used to supply steam at 90-lb. pressure for the laundry.

It may be pertinent to state that under former conditions of operation it was found necessary to use all boilers. By substituting high-class stokers in the remodeled plant and paying close attention to combustion, high efficiencies were obtained and the coal consumption was less than in former years by over 500 tons, these results being obtained while the temperature averaged five degrees colder for the season than in the preceding year. The labor reduction amounted to three firemen from the hospital plant, three from the jail, two more from the Jacobs Building and one from the Board of Health Building—a total of nine men. The cost of the new stokers and of the work incidental to connecting up the buildings and installing coal- and ash-handling equipment was $70,000, while the saving for the year netted $13,300, which amounts to 19 per cent on the investment. This is a saving of no mean proportion, but the limit has not been reached.

For the results obtained in the remodeled plant credit is due Porter Murphy, Superintendent of Public Buildings for Detroit, and Frank Quandt, chief engineer of the plant.

Making a Chart To Show the Addition and Rejection of Heat in Engines

WORK and heat are mutually convertible. The heat added to the steam in the boiler is converted into work in the engine cylinder. The work thus developed is used in overcoming engine and machine friction. The remainder, which is used in doing effective work, finally reappears somewhere in the form of heat. As example, in boring a casting the work done reappears as heat in the casting and boring chips. This work has a well-defined relation to heat called the Joule. It has been found that a definite amount of heat is required to raise one pound of water one degree in temperature; this heat is taken as a unit by which to measure other amounts and is called a British thermal unit (B.t.u.). Experiments have shown that this amount of heat when converted into work is equal to about 778 foot-pounds, this being the Joule.

Now the steam, air, gas or whatever is used in the engine is merely the medium that carries the heat and it is the heat alone that is converted into work. After expansion in a cylinder the amount of steam going to the condenser is just equal to the weight of steam evaporated in the boiler and fed to the engine. While substances may act differently, such as increasing in temperature at different rates upon the addition of equal amounts of heat, still we are actually dealing with heat just as we are dealing with work alone whether it be developed in a waterwheel or a steam engine.

As has been shown in previous articles on the steam-engine indicator, the work in foot-pounds done in the

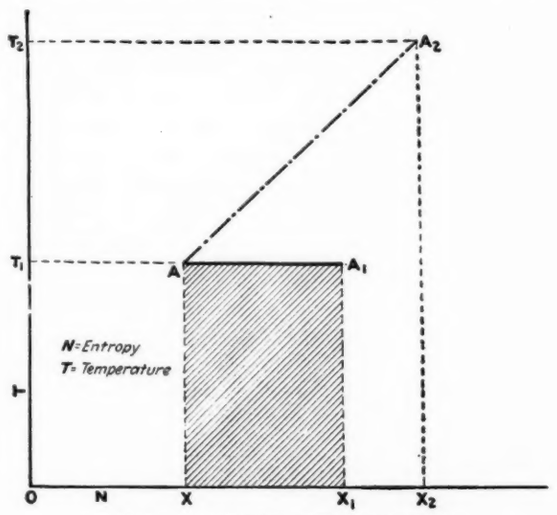


FIG. 1. ADDING HEAT TO AIR

cylinder of an engine by the pressure exerted on the moving piston may be represented by an area, the ordinate of which represents pressure, while the abscissa represents distance moved.

It is possible likewise to construct a chart showing the heat contained in a given quantity of a medium, as air, gas or steam, and show by the increase or decrease in the diagram area, the amount of heat added to or taken from the air. As example, in Fig. 1 we have a pound of air in the condition indicated by the point A and containing an amount of heat H_1 proportional to the area $OXAT_1$. This area, representing the heat H_1 has one side OT, proportional to the temperature T_1 measured from absolute zero temperature (this is 460

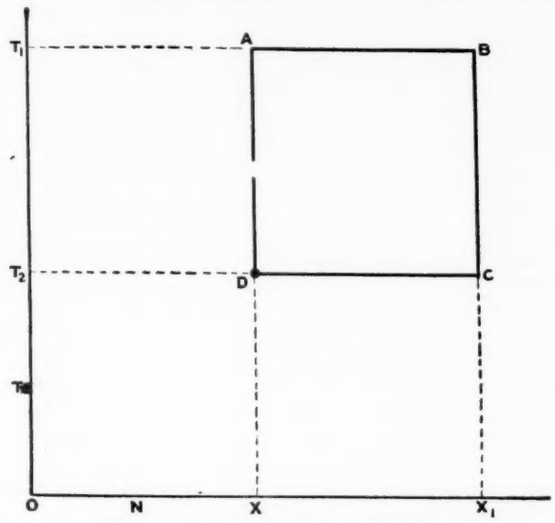


FIG. 2. CARNOT CYCLE FOR AIR

deg. below zero on the Fahrenheit scale). The other side OX or N is equal to the area divided by OT_1, and is proportional to $\frac{H_1}{T_1}$ and may be called the heat weight or by its more common name, entropy.

Now, if heat is added the air at a constant temperature T_1, we will have the diagram area increased and since the temperature is constant, A will move horizontally to, say, A'. Our heat diagram is now $A'X_1OT_1$, the increase being the area AA_1X_1X. It will be noticed that when heat is added at constant temperature, the entropy increases proportionally to the heat added for in the relation $\frac{H}{T} = N$, T is constant. Heat may be added in other ways than constant temperature, as indicated by the dotted line AA_2, Fig. 1, where the temperature varied from T_1 to T_2 and the entropy, or relation of $\frac{H}{T}$, varied from X to X_2. The heat added from A to A_2 is the area XAA_2X_2. Likewise a complete cycle of adding and subtracting heat in the form of work may be represented on such a diagram.

One of the cycles of heat addition and rejection is called the Carnot cycle, and this process is the most efficient utilization of heat between any two temperature conditions. The entire theory is too complicated to present here, but its heat diagram and the method of accomplishing it in an ideal engine can be shown.

Start with any amount of air, say one pound, at a temperature T_2 indicated by the distance DX from zero temperature in Fig. 2 and containing an amount of heat proportional to the area $DXOT_2$. This air we will assume to be in a cylinder with the piston at D, Fig. 3a. If the piston is forced into the cylinder com-

pressing the air, all the work of compression, if the cylinder walls are non-conducting, reappears as internal heat of the air; the temperature and pressure increase, the temperature increasing in direct proportion to the heat added or work done. If when the piston reaches A, Fig. 3b, the heat added is one-half of the total heat in the air when the piston is at the beginning of the stroke, the heat contained in the air at A is one and one-half heat at D. The temperatures at D and A, Fig. 2, are in like proportion, or $T_1 = 1.5\ T_2$. The total heat at A is proportional to the area AT_1OX, Fig. 2, and this area is 1.5 times DT_2OX. If, now, we add heat to the contents of the cylinder and keep the temperature constant by allowing the piston to move outward, when the piston reaches B, Fig. 3c, the heat in the air is proportional to the area BT_1OX_1, Fig. 2. If the supply of heat is discontinued at B and the piston allowed to be forced outward by the hot air until it reaches C, the end of the stroke, Fig. 3d, the air when at C, Fig. 2, contains heat proportional to the area CT_2OX_1. It will be noticed that during this expansion from B to C no heat was added, and the reduction in area is due to part of the heat being converted into work. The temperature dropped in direct proportion to the loss of heat and the entropy was constant. To bring the change of air back to its original condition of D, Fig. 2, it is necessary, by cooling, to throw away the heat at C over and above the heat contained in the air at D, this heat being removed at the constant temperature of T_2. In Fig. 3d the piston in moving from C to D reduces the volume with the temperature constant, this being isothermal (constant temperature) compression. This is the complete cycle of events of the Carnot cycle. It will be noticed that the process consists first of compression from D to A (work done on the air) without loss to the cylinder walls, and that the temperature increases directly as the increase in heat; in other words, the entropy remains constant. From A to B we have heat added at constant temperature and to do this the air

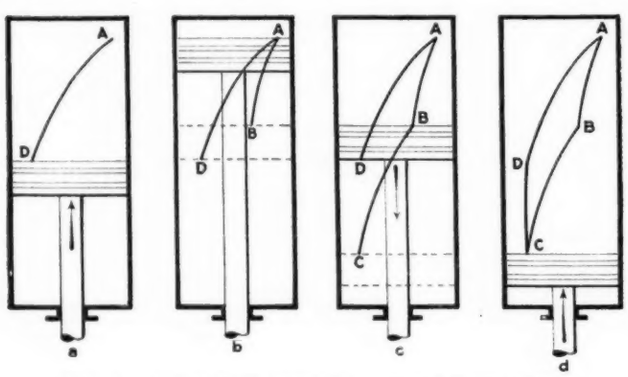


FIG. 3. CYLINDER EVENTS OF CARNOT CYCLE

was allowed to expand; this is isothermal (constant-temperature) expansion. During this time the entropy was not constant, but increased in direct proportion to the increase in heat. From B to C the work of expansion used up part of the heat, and the temperature fell in direct ratio to the heat converted into work, or $\frac{H}{T}$ (the entropy) was constant. From C to D heat was thrown away at constant temperature. This reduced the volume of the air, and it was necessary to move up the piston until the volume shrank from D to A. This is isothermal compression. The entire cycle is represented on the PV diagram, as shown in Fig. 4, consisting of two adiabatics and two isothermals.

In this Carnot cycle, as with all systems of converting heat into work, the heat converted into work is the difference between the total heat added and the heat thrown away. The area added by the work of compression from D to A is DAT_1T_2 and that due to the addition of heat from an external source is ABX_1X. The heat converted into work during expansion from B to C, is proportional to BCT_2T_1 or $DABC + DT_2T_1A$. From C to D the heat thrown away was proportional to $CDXX_1$. Of the

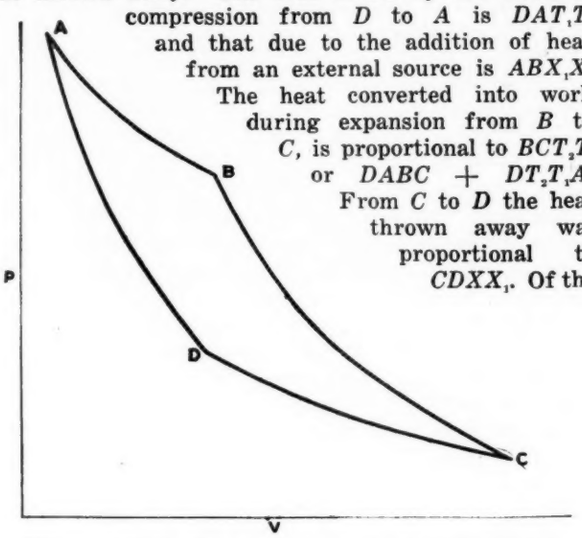


FIG. 4. INDICATOR DIAGRAM OF CARNOT CYCLE

heat added during the cycle, that amount represented by $DABC$ was used in doing work and that represented by $CDXX_1$ was thrown away. The efficiency of an engine operating on any cycle is the heat converted into work divided by the heat added. This for the Carnot cycle may also be expressed as

$$\text{efficiency} = \frac{ABX_1X - CDXX_1}{ABX_1X} \text{ or } E = 1 - \frac{CDX_1X}{ABX_1X}.$$

The entropies XX_1 being the same, the two areas are proportional to the temperatures at T_1 and T_2, so we may write the expression as $E = 1 - \frac{T_2}{T_1}$ or $\frac{T_1 - T_2}{T_1}$.

Heat may be added at other than constant temperature and may be rejected at other than constant temperature, but the maximum possible efficiency of any process of converting heat into work is that of the Carnot cycle, and this cycle is used as the basis of comparison for engines using a gaseous medium.

A somewhat similar chart may be made to show the process of steam generation in the boiler, cylinder feed, expansion in the engine and rejection to the condenser. If we take a pound of water, or rather ice, at zero absolute (—460 F.), the heat contained would be zero B.t.u. If heat were applied, the temperature would gradually increase, the relation being shown by the curve OS, Fig. 5, the area under the curve being the heat in B.t.u., the ordinate indicating temperatures and the abscissa being the entropy or heat weight. The temperature at S is 32 deg. F., and at this point any further addition of heat is not followed by a temperature rise. Instead the ice melts, and no change in temperature occurs until 142 B.t.u. are added, this being the *latent heat of fusion* of ice or water and is the heat given up by the melting of one pound of ice at 32 deg. F. Addition of heat now causes the temperature to rise at a rate such that the area under the curve from I to A or $VIAW$ is proportional to the heat added to raise the temperature from 32 deg. to

any temperature T_1 at *A*. If now the pressure in the boiler is such that it is that pressure at which water will boil when at a temperature T_1 the further addition of heat will cause no increase in temperature, but the water changes into steam, absorbing a large amount of heat represented by the area *ABRW*. This is the latent heat of evaporation. If, instead of carrying a pressure corresponding to T_1, the boiler had been under a pressure corresponding to, say T_3, then when the temperature of the water reached T_3 boiling would have begun, and when the whole pound of water has evaporated the heat added must be proportional to the area $T_3B_1R_1W_1$. If a number of boiling temperatures be taken and the latent heats at these temperatures be set down, we will have the points *B*, B_1, etc., on a curved line *HK* called the situation or steam line.

Now in steam engineering we are not concerned with the condition of the steam substance at temperatures below normal, and so instead of measuring the heat of the liquid from zero absolute, another line *YV* is drawn through the 32-deg. temperature point and all the chart to the left of this line is ignored. We now have the familiar *T* — *N* diagram for steam, Fig. 6. All the heat required to be added to the water at 32 deg. F. to convert it into steam at any pressure, is measured from the new zero entropy line *YV*.

The heat that must be added to raise the water from 32 deg. F. to the boiling temperature T_1 corresponding to the steam pressure is the area *OIAG*. This is the heat of the liquid shown in the steam table and is represented by symbol *h*. The heat added to evaporate all the pound of hot water into steam is the area *ABJG*, this being the latent heat of evaporation *L*.

If, now, steam in the dry saturated condition represented by *B* in Fig. 6 is expanded in a cylinder without loss of heat other than that converted into work, as shown in the discussion of the action of air in Fig. 2, the entropy will remain constant during this adiabatic expansion. At *C* expansion

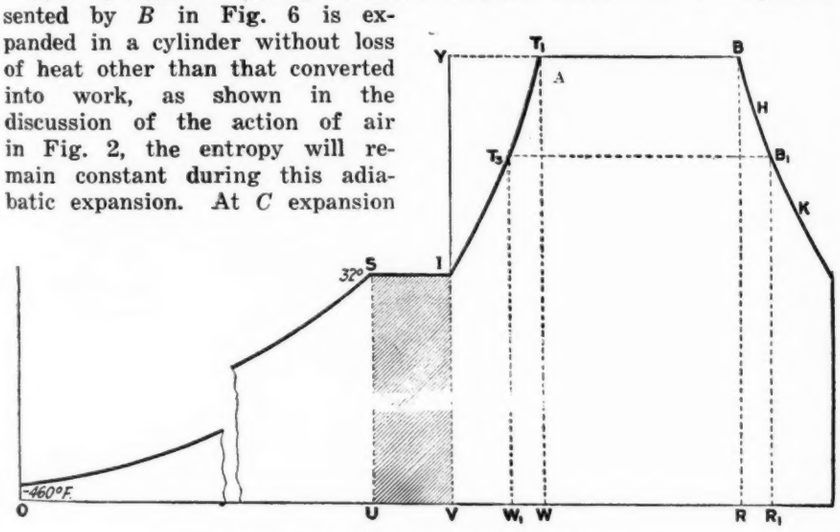


FIG. 5. RESULTS OF HEATING WATER

ends and the piston on the next stroke forces the exhaust steam out into the condenser, where enough heat is absorbed to condense the steam into water at a temperature of T_2, losing the latent heat *CDLJ*. The liquid is now at *D*, and to raise it to the boiling point it is necessary to add the difference between the heat of the liquid at T_1 and at T_2 or $h_1 - h_2$, represented by the area *DAGL*. To evaporate the water, the latent heat *L*, represented by the area *ABJG*, must be added. The total heat added to the pound of water during the cycle is the area *DABJL*, while the heat rejected to the condenser is the area *DCJL*. The thermal efficiency of any engine no matter what medium is used, is the heat converted into work divided by the heat added.

The heat added area *DABJL* is made up of the entire area *OIABJ* minus the area *OIDL*. The area *OIABJ* is proportional to the total heat in a pound of steam at the pressure *B*, or to H_1. The area *OIDL* represents the heat in a pound of water at the condenser temperature; this is the heat of the liquid h_2. The heat added is then $H_1 - h_2$. The heat converted into work is the area *DABC*. Take the total area *OIABJ* (or H_1) and subtract the area *OIDL* (or h_2). This leaves the area *DABJL*. Now the distance *OL* is the entropy n_2 of the liquid at condenser temperature of T_2. The distance *OJ* is the entropy N_1 of the steam at the boiler temperature of T_1. The height *JC* is equal to T_2, the condenser or boiler feed temperature. The area *DCJL* is then equal to $(N_1 - n_2)T_2$. The area *DABC*, or the heat converted into work, is then $H_1 - h_2 - (N_1 - n_2)T_2$. The efficiency of the cycle becomes

$$\frac{H_1 - h_2 - (N_1 - n_2)\,T_2}{H_1 - h_2}.$$

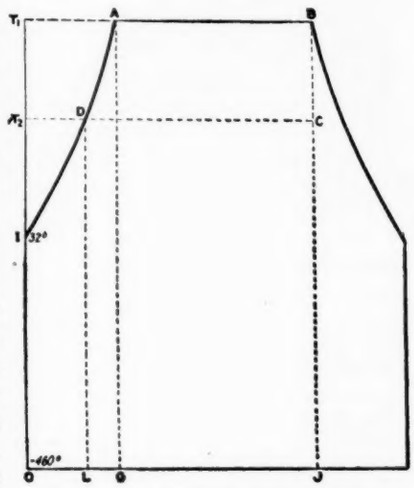


FIG. 6. T-N DIAGRAM FOR STEAM

The values of these factors are found in the steam tables under the proper heading. The efficiency so obtained is the theoretical efficiency of an engine that has no exchange of heat to or from the cylinder walls and that expands down to the exhaust pressure and has no compression, the cycle being called the Rankine cycle. While in this discussion it was assumed that the engine was fitted with a condenser, the cycle of events is the same even exhausting to the atmosphere, for to all intent this is the same as condensing the steam at atmospheric pressure and using the same pound of water over again, although the original water is thrown away and a new supply put into the boiler. Knowing the condition of the steam pressure and exhaust pressure, it is possible to calculate by the use of the expression, the heat converted into work by a perfect engine working on the Rankine cycle; that is, work $= H_1 - h_2 - (N_1 - n_2)\,T_2$ in B.t.u.; or work per pound of steam of a Rankine engine may be expressed in terms of pounds of steam per indicated horsepower by dividing the equivalent of one horsepower-hour, or 2,545 B.t.u. by the foregoing result. Comparison with the actual water rate will show how close the engine is approaching the ideal.

Behavior of Lubricating Oil in Steam Turbines

By W. F. OSBORNE
Supervisor Manufacturers' Service of Texas Company

CONTRARY to the opinion of many engineers the steam turbine is comparatively simple to lubricate so far as the formation and maintenance of a lubricating film is concerned. The high speed of the turbine shaft has a great influence in increasing the wedging action of the oil and in centralizing the shaft with respect to its bearings.

A properly designed turbine bearing offers an ideal opportunity for the formation of a perfect lubricating film. The high speed combined with small bearing loads makes it easy to secure minimum friction within the bearing with the use of oils of comparatively low viscosity. The viscosity of course depends on the mechanical and operating conditions, the same as in all other circulatory systems. The great advantage that the steam turbine has over the steam-engine bearing is in the higher speed of the shaft and the fact that the loads are steady instead of fluctuating as in the steam engine.

With the exception of some of the small sizes, practically all steam turbines are equipped with some sort of a circulatory system. Most of the systems are force-feed, either direct to the bearings under pressures ranging from two to fifteen pounds, or to sight-feed regulators which reduce the pressure of the oil as supplied to the bearings, but furnish a means of regulating the quantity.

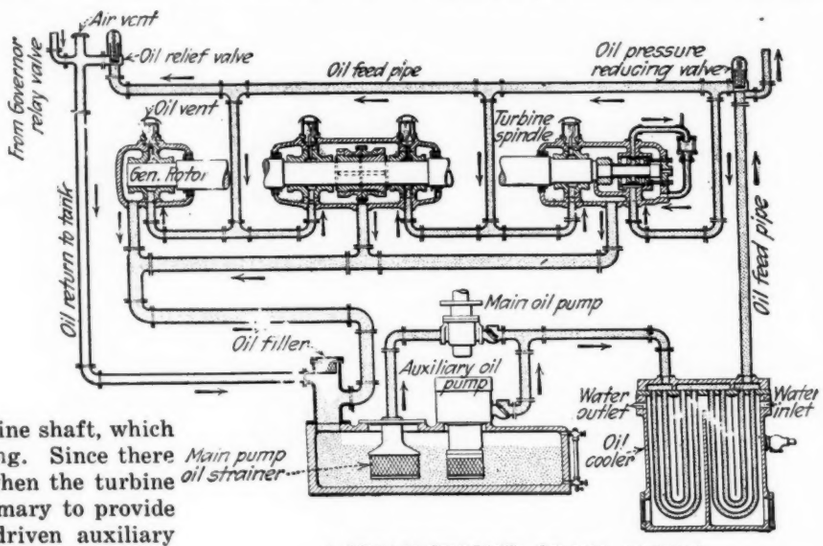
These force-feed systems receive their oil from a pump geared to the turbine shaft, which operates as long as the turbine is running. Since there is little oil remaining in the bearings when the turbine has been idle for some time, it is customary to provide the turbine with a steam- or electric-driven auxiliary pump to furnish a supply of oil when first starting, until the geared pump is up to speed.

The oiling system of the steam turbine is not very different from that of the steam engine, and in fact many steam engines have systems identical with those usually employed on steam turbines. Unfortunately, in many instances the capacity of the steam-turbine oiling system is much smaller than it ought to be, so that the oil is subjected to severe service conditions. In order that the bearings receive sufficient oil to maintain the lubricating film, it is necessary to circulate the oil at a high rate of speed, so rapidly sometimes that it does not afford time enough for the moisture and sediment to settle out. In such systems it is a common occurrence to find the oil always in a milky or opaque state, due to the moisture it carries.

Such a condition can be remedied only by increasing the capacity of the system and reducing the rate of oil flow, or by installing suitable filters or separators to clean the oil continuously as fast as it is circulated.

The turbine oiling system, contrary to most steam-engine oiling systems, is fully inclosed, with little opportunity for leakage of oil or oil vapor. Hence the makeup will be small, and the oil lasts a long time. The low evaporation and long service render a turbine oil particularly susceptible to decomposition or emulsification in the presence of moisture, and on this account only the highest-grade filtered oils should be used.

Moisture in the oiling system is a common cause of trouble, and alkaline water coming over from the boiler with the steam may cause emulsification. The system, being so tightly inclosed, receives very little foreign matter from the atmosphere, but there is always the possibility of moisture getting into the oil and causing rust and corrosion. Sludges and deposits are frequent in many turbine systems, which have not been properly designed to remove the moisture getting into the system. Sometimes, too, an improperly refined oil or the use of an oil not intended for steam-turbine oiling systems will cause sludges and deposits. Such deposits frequently settle on the cooler pipes and, by insulating them, prevent proper cooling of the oil. Its temperature rises and decomposition follows.



A STEAM-TURBINE OILING SYSTEM

In certain turbine-oiling systems the oil will foam and occasionally it will increase in volume to such an extent that it will overflow the reservoir. The foaming may be caused by too little oil in the system, rapid circulation or a fall of some distance from the mouth of the return line to the reservoir. Foaming may also be caused by air drawn into the oil through leaky pump suction lines or forced into the oil by the ventilation system of an electric generator. Decreasing the viscosity will sometimes aid in reducing foaming when it is not possible to eliminate the air.

The general operation of the turbine oiling system is quite similar to that of any other system with the exception that every precaution should be taken to keep the oil in good condition. The high speed of the

turbine shaft, while it assists in maintaining the oil film, will also cause the bearings to be destroyed very quickly if anything happens to the oil supply.

Having selected an oil that is properly refined to meet the service conditions of steam-turbine work, it is then necessary to select the correct viscosity. Almost every oil refiner has a number of turbine oils of equal quality and of different viscosities. The correct viscosity is determined by experience in the lubrication of many turbines and depends a great deal upon the speed and the normal operating temperature of the bearings as influenced by the amount of heat conducted from the turbine casing. Usually, the bearing on the steam end will be ten or fifteen degrees hotter than the bearing at the exhaust end. In selecting the viscosity, the hottest bearing should be taken into consideration.

The temperature viscosity curves of some of the most widely known turbine oils on the market are shown in the chart. The engineer should select the oil having the lowest viscosity that will maintain a proper film at the normal operating temperatures of his bearings, making due allowance for a sufficient margin of safety to prevent metallic contact in case the temperature should be raised temporarily to an abnormal point. When the correct viscosity has once been secured, the oil should be maintained at that point by proper manipulation of the coolers.

The smaller turbines have ring-oiled bearings, and when they are situated close to the turbine casing, their temperatures may become very high—sometimes as high as 250 deg. F. Such bearings require an oil of sufficient viscosity at their operating temperatures, 200-250 deg. F., to prevent metallic rubbing and high frictional losses. The proper procedure is to determine the bearing temperature by using a medium-bodied oil, and then if the medium-bodied oil has too low a viscosity at this temperature, as may be seen from the curves, a higher viscosity may be used.

Schutte & Koerting Mechanical Oil Burner

In Fig. 1 is shown the atomizer of a mechanical oil burner in which atomization is produced by forcing the oil under a pressure of 125 to 250 lb. per sq.in. tangentially through a circular chamber so arranged as to give the oil a high velocity of rotation, and thus under the action of centrifugal force to break it up

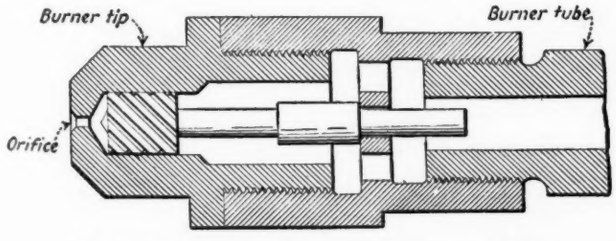


FIG. 1. SECTION OF MECHANICAL ATOMIZER

into finely divided fog-like particles. The circular chamber of the tangential groove discharges into a small cylindrical chamber, the tip end of which is coned out. At the apex of the cone is the orifice through which the oil is discharged into the furnace.

As the oil leaves the orifice under the influence of the three forces, due respectively to centrifugal action of rotation, translation along the axis of the atomizer and gravity, it spreads out into the form of a hollow cone made up of finely divided particles. The cone is uniformly thin throughout, readily admitting of a complete mixture with air.

The burner atomizes the oil without clogging, and the hollow cone shape of the oil discharge insures an intimate mixture at all points with the combustion air

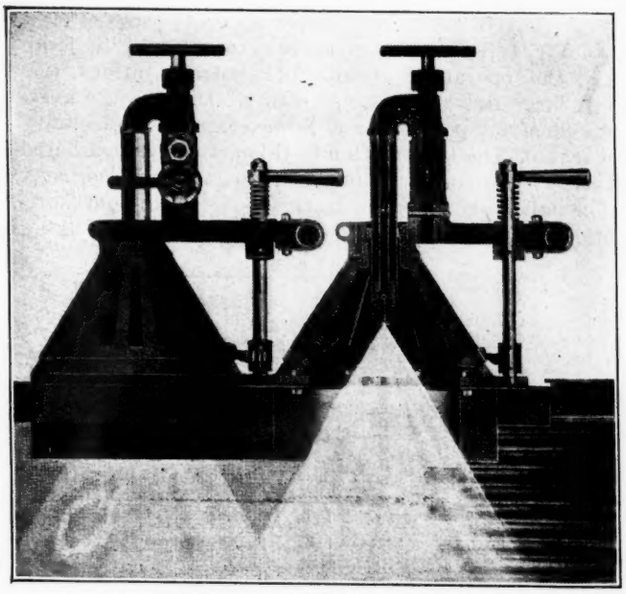


FIG. 2. AIR-CONTROL REGISTER FOR USE WITH FORCED DRAFT

and secures complete combustion with the minimum excess of air.

The mechanical burner is adapted either for forced- or natural-draft installations. Fig. 2 shows the air-control register for use with forced draft. This register consists of two concentric conical shells provided with radial peripheral openings. The inner cone is fixed in position, whereas the outer cone can be revolved, thereby varying the opening and as a result the amount of air admitted to the burner. The openings may be readily adjusted to give at all times the proper air supply for the existing rate of combustion.

The air, in passing through the type of air-control register shown, is given, by means of deflecting plates or baffles set at an oblique angle with the register openings, a swirling or twisting motion, and is brought into intimate contact with the finely divided particles of oil issuing from the burner.

This mechanical oil burner is manufactured by the Schutte & Koerting Company, of Philadelphia, Pa.

Overtravel of an elevator car at the top of the hoistway is the distance which the empty car or platform will travel above the top terminal landing under normal running conditions, until stopped by automatic means independent of the manual car control. Overtravel at the bottom of the hoistway is the distance available for the car platform to travel below the lower terminal landing without any part of the car construction being obstructed, except by the bumpers or buffers installed in the pit. The movement of the car necessary to fully compress the bumpers or buffers may be included in the overtravel at the bottom.

An Example of Good Industrial Power-Plant Operation

By DOUGLAS HENDERSON
Chief Engineeer, Fuel Engineering Company of New York.

ARTICLES frequently appear containing in detail the operating results of central stations and large industrial power plants. Data on the average industrial power plant, however, are fragmentary and scarce. The information in this article was gathered from a clock-manufacturing company in New England.

The boiler plant at this factory consists of four horizontal return-tubular boilers, equipped with shaking

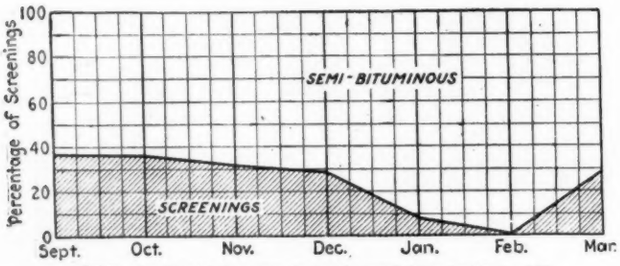


FIG. 1. CHART SHOWING PERCENTAGE OF SCREENINGS USED.

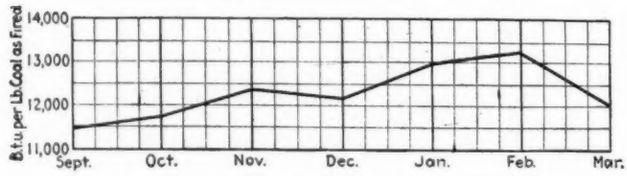


FIG. 2. B. T. U. PER POUND OF COAL AS FIRED.

grates. Each boiler has 1,700 sq.ft. of water-heating surface, the shell being 72 in. x 18 ft., fitted with 98 x 3½-in. x 18-ft. tubes. The grate dimensions are 6 ft. x 6 ft., making an area of 36 sq.ft., or a ratio of heating surface to grate surface of 47.2 to 1. Rear-end soot blowers are installed and used twice a day, to assure cleanliness of heating surfaces.

The draft is supplied by a stack 100 ft. high and 5 ft. in diameter, which, according to accepted data on stack capacities, is sufficient for a grate area of 120 sq.ft. Three boilers carry the load, so that the total grate area would amount to 108 sq.ft., or a stack rating of 90 per cent. This draft is regulated to suit the steam-load conditions by the hand operation of the individual uptake dampers.

The boilers have several instruments for the guidance of the firemen, including a CO_2 recorder and a pyrometer, both instruments being so arranged as to permit shifting from boiler to boiler. A 24-hour record is obtained from each instrument from one boiler, after which they are changed to give the same information on another boiler. The feed water is metered through an integrating and recording flowmeter. The coal wheeled into the boiler room is weighed on platform scales and the weight recorded. Records from feedwater thermometer and steam-pressure gage complete the data supplied by instruments.

Small quantities of coal and ash are gathered each day in separate containers until at the end of the week there has been collected about a 600 lb. sample of each. They are then quartered down for analysis, thus completing the boiler-plant data.

The seven months beginning September, 1921, to March, 1922, inclusive, have been selected to show how the operating results varied and to what extent they could be controlled to produce the best results.

The weekly coal samples averaged for each month gave the following data:

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Moisture	4.27	4.17	3.68	4.99	4.52	4.03	5.24
Ash	18.42	16.73	14.35	13.79	10.37	10.74	14.98
Volatile	13.18	14.10	13.67	14.98	20.60	21.53	17.75
Sulphur	0.67	0.79	0.79	0.66	0.96	1.01	0.62
B.t.u.	11,476	11,753	12,365	12,168	12,976	13,218	12,040

The entries made in this tabulation are based on the coal as fired.

It can be seen that there is a marked improvement in coal quality from September to February and then in March a slump takes place. This is due to the fact that this plant burns a mixture of semi-bituminous and anthracite screenings, and during these months the proportions of the mixture are changed. The chart brings

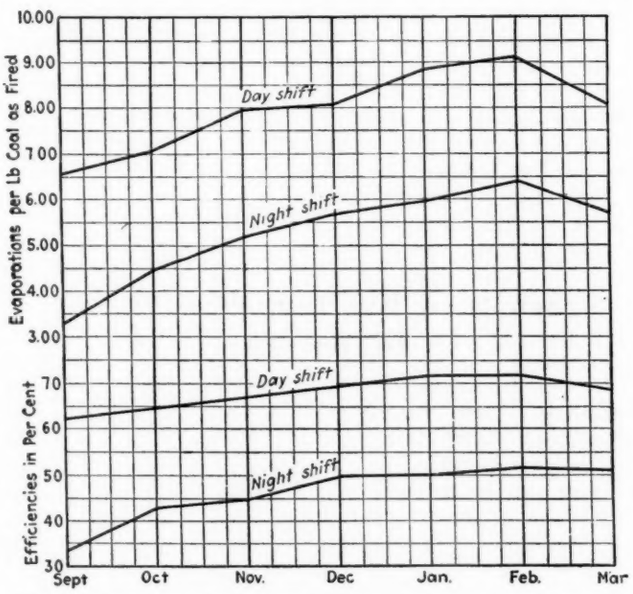


FIG. 3. EVAPORATION PER POUND OF COAL AS FIRED AND EFFICIENCY IN PER CENT.

this out clearly and indicates that during February only semi-bituminous coal was burned.

In this particular plant there is a day and a night shift, making it necessary to divide the results into these two classes. During the night the boilers are all operated in a banked condition, what little steam is used being supplied for heating purposes. During the summer months this is practically negligible, while for the winter it is considerably greater. The percentage over-all efficiency of the boilers for the day and night shifts can be seen from the following table:

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Day	62.22	64.75	66.96	69.26	71.35	71.36	68.35
Night	33.18	42.85	44.74	49.64	49.47	52.12	50.78

Here again can be detected a tendency for the efficiency during the day to increase somewhat with the

coal quality until February, during which the highest value is reached. The night-shift efficiency does the same thing only to a greater degree, largely because the night load grows heavier with the approach of the cold weather. During the summer months the night load is entirely a stand-by loss.

Combining the calorific value of the fuel burned each month with the efficiency developed gives these figures for evaporation:

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Day.....	6.56	7.07	7.95	8.05	8.87	9.10	8.06
Night.....	3.30	4.47	5.15	5.67	5.97	6.40	5.70

It must be remembered that these evaporations are based on the number of pounds of water actually evaporated per pound of coal as fired. The record thus made can better be appreciated from the chart, Fig. 3.

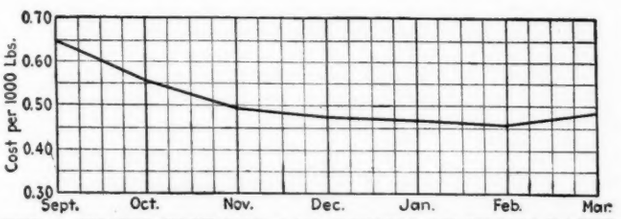


FIG. 4. SHOWS COST PER 1,000 POUNDS OF STEAM BASED ON COAL ONLY.

These results bring out an interesting point and one that is quite frequently overlooked in industrial power plant operation, which is, that the cheapest coal is not necessarily the fuel that produces the most economical results. At this particular plant semi-bituminous coal at the time these figures were obtained was being purchased at $7.86 per gross ton delivered to the boiler room, while the anthracite screenings cost $5.92 per gross ton delivered.

Mixing these two fuels in the proportions shown in Fig. 1 and developing the evaporations as shown in Fig. 3, produced a cost per 1,000 lb. steam as follows, based on coal only:

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Cost per 1,000 lb.	$0.645	$0.555	$0.492	$0.475	$0.465	$0.453	$0.487

This is an average cost for the day and night shifts, and when shown graphically it brings out sharply that the best operation from an economy standpoint for this plant was obtained during February when semi-bituminous coal was fired without mixing with the anthracite screenings. The actual cost per ton of coal burned was consequently the lowest in this month.

Each month a heat balance is struck for this plant, which tells the distribution of heat based on the combustion of one pound of coal. The aim is to keep the preventable losses to a minimum and thereby derive the maximum results. A typical heat balance follows:

	Per Cent
Heat absorbed by the boilers	71.40
Stack loss	16.36
Loss through grates	2.28
Loss due to moisture in coal	0.42
Loss due to hydrogen in coal	3.59
Radiation and unaccounted for	5.95
	100.00

These results represent every-day achievements and are not in any way affected by "test conditions," as is usually the case when boiler tests are conducted. They are based on twenty-four hours per day and covering the number of days per month, Sundays included. Considering the influences that enter into boiler-plant operation, such as load variations, personnel of fire-room and changing coal quality, this is a good record.

The Operation of Edison Storage Batteries

By L. W. WEBB

Edison storage batteries differ from all other types on the market in that they are of the alkaline type where the others are of the lead-acid type. The elements are made up of nickel and iron and are installed in a nickel-plated sheet-steel can, immersed in a 21 per cent solution of potassium hydrate (caustic potash) in pure distilled water. This makes a cell that is light in weight per unit capacity, can stand extreme conditions of jar or vibration, has a long active life, and can be discharged completely and left in that condition without any great deterioration.

Its voltage is less, however, than the lead cell, and therefore it requires a greater number of cells to obtain the same voltage as from a lead battery. Its discharge voltage is not as constant, but falls more gradually than the lead battery, which becomes fairly constant shortly after beginning of discharge until about 80 or 85 per cent of normal output is reached. As the alkaline-type is more expensive in first cost than the lead-type cell, its use, even in its most favorable applications, has not been as general as it would have been if the cost were closer to that of the lead-type cell.

The positive plates, Fig. 1, are made up of tubes of very thin nickel-plated perforated sheet steel secured to a nickeled-steel grid. The tubes are reinforced by

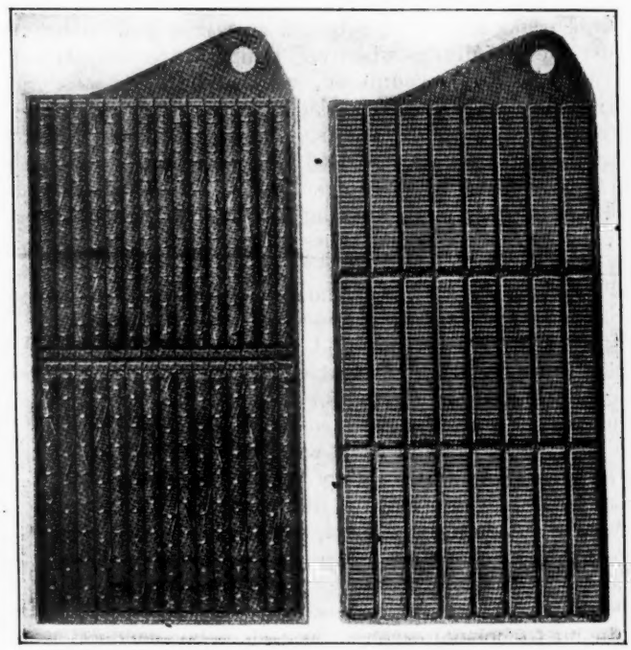


FIG. 1. POSITIVE PLATE FIG. 2. NEGATIVE PLATE

equidistantly spaced steel seamless rings and filled with layers of very thin pure metallic nickel flake and nickel hydrate, alternately placed and solidly packed by a special loading machine. The metallic nickel acts as the conductor between the containing tube and the active material, nickel hydrate. The negative plates (Fig. 2) are made up of nickel-plated steel grids, and the active material (iron oxide with a small percentage of metallic mercury to increase conductivity) is first packed into small perforated and corrugated steel pockets and then

placed in the interstices of steel grid and hydraulically pressed in. The two groups are then assembled (using one more negative than positive) and insulated apart by vertical hard-rubber rods.

The complete cell consists of a positive element (pure flake nickel and nickel hydrate) and a negative element (iron oxide) immersed in a dilute solution of potassium hydrate (caustic potash) about 1.235 specific gravity. This cell gives from about 1.4 volts across terminals while discharging down to 1 volt where it is considered discharged. The unit quantity of this battery (as with the lead cell) is the ampere-hour, and the number of amperes flowing from full charge to discharge voltage of 1 volt multiplied by the number of

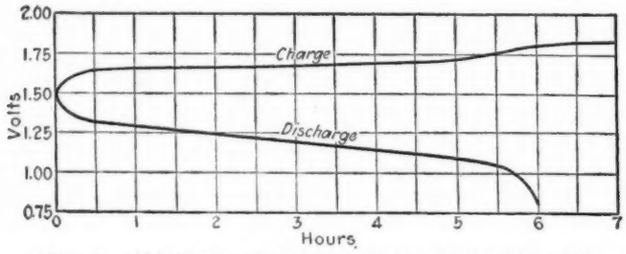


FIG. 3. VOLTAGE CURVES DURING CHARGING AND DISCHARGING PERIODS

hours the current is flowing gives the rating in ampere-hours. The normal rating is usually on a five-hour discharge basis, but the ultimate output varies as the rate is increased or decreased somewhat as the lead battery. It, however, usually cannot give as high current discharge peaks as can be obtained from the lead battery. This is especially so when cell temperatures less than 50 deg. F. are encountered, which often happens in extremely cold weather operating conditions under intermittent duty requirements. The cells have a higher capacity after several months' use than when new, due to improvement of the nickel electrode by charging and discharging and working the active material up into better shape in the tubes than the original packing could give.

The discharge rating of the Edison battery has been arbitrarily fixed and determined largely by the capacity of the positive electrode and the voltage point below which it would not be desirable to run, as well as from the input-output efficiency for average practice, but a larger capacity can be obtained at any time by discharging to a lower voltage limit without doing any injury. In an emergency where every bit of available power is needed, the battery may be discharged to almost zero volts without doing any damage to elements, and a mistake made in charging in the wrong direction usually means only the loss of energy for that particular time plus the extra amount necessary to bring the battery again up to normal when proper charging connections are re-established.

The voltage during discharge varies from 1.45 volts to 1 volt when normal capacity is considered reached. At beginning of discharge the voltage drop is rapid for the first 30 min., dropping from 1.45 to 1.32 volts; then falls steadily for the next 5 hr. to 1.1 volts, when it again drops more rapidly for the next half hour to 1 volt, where normal capacity is reached. This in reality gives approximately 16 per cent more discharge than the name-plate rating as given by the manufacturer as normal rating. The average voltage during this discharge is about 1.2 volts.

The voltage during charge for seven hours at normal current rates (at which the battery is considered fully charged) starts at about 1.45 volts and rises rapidly for the first 30 min. until about 1.64 volts and then continues almost steadily for about 2 hr. and then starts rising gradually until 1.8 volts is reached about ½ hr. before the end of charge, and then goes up to about 1.82 the next half-hour, when the battery is considered fully charged. Charging at currents above or below normal rates gives voltages slightly higher or lower, but the curves follow the same general lines. The curves Fig. 3 give typical voltage changes during charge and discharge as already described. Voltages also vary with temperature and internal resistance of cell.

Renewing of the Electrolyte

As the density of the electrolyte is practically constant during charge and discharge, the only losses encountered are due to the small quantities that escape by the check valve with the minute hydrogen and oxygen gas bubbles. Owing to this loss, the density of the electrolyte slowly decreases, and when it drops to 1.16 sp.gr. it should be renewed with fresh solution.

The capacities of the cells increase for increase of temperature up to as high as 132 deg. F. on discharge. Temperatures on charge higher than 110 deg. F. result in a loss of capacity for that particular charge, but apparently do no particular damage to the elements themselves. Cell temperatures of 50 deg. F. or lower do not give capacity and result in wasted energy in heating the cells, as at these temperatures the internal resistance of the cell is much higher than at normal temperatures. High discharge rates cannot be obtained at low temperatures, and where high discharge rates are necessary, especially in cold climates, the cells should be kept protected against cold and arranged to retain as much as possible of the heat generated in them during the previous discharge or charge period. It is therefore desirable if the batteries are to remain for any length of time not working, to have them in a warm place if possible, as then they will more quickly respond to high current discharge rates.

Jars or cells consist of sheet-steel retaining cans, corrugated on the sides to give the greatest amount of strength with minimum weight, and the seams are welded. As it is impossible to get inside of cells to make repairs or to replace jars if they become rusted out or defective for any reason, they have to be sent to the factory to have the old jars burnt off and new ones installed.

Taking Battery Out of Service

The cells are readily and easily taken out of commission by first charging them up to capacity and bringing the solution to the proper level, giving a slight overcharge and then thoroughly cleaning the outside of container and cell terminals and wiping a thin coating of vaseline over all and putting aside in a dry place until needed again. Be sure filler cap and valve are down tight to prevent undue evaporation of electrolyte. While the foregoing is the proper method and requires very little time to do properly, no great harm is done if cells are allowed to remain in any condition of charge or discharge for any period of time as long as the solution level is not allowed to get below the tops of the plates and the containing cans are properly greased or painted to protect from rusting.

EDITORIALS

Maintenance of Morale Among Younger Employees

LAST month there emerged from the universities and technical schools of this country several thousand young men with engineering degrees, little practical experience and scant notion of what work they are best fitted for, but with determination to make their way in the engineering profession. It is well worth while, therefore, to take pains in maintaining interest and ambition among the young men who come into an organization with uncertainty as to their future in it. They will sooner or later furnish the men for positions of responsibility. It is just as important that their relation to the organizations be maintained on the proper basis as that their training in technical matters and in the ways of the individual concern be properly planned.

The recent experience of one such young engineer will illustrate the pitfall in which many others doubtless fall. This young man had been taken into a large engineering organization. He was given rather minor positions in one department after another, all as a part of his training for more responsible work. Unfortunately, it had not been explained to him that this early work was simply a further schooling to fit him for broad and responsible service in the line of his chosen profession. After three or four shifts from one job to another, each job seeming to him quite petty, he became thoroughly discouraged. In fact, he was about to resign because he felt that after a year or more he was still doing work that any boy fresh from high school could do equally well. He did not see that he was any nearer a real engineering job after this time than on the first day with the concern.

The scheme of training that this company has is widely recognized as sound and effective. But in this particular case it lacked one detail of great importance, namely, the inspiration to the individual that could be afforded by promise of larger opportunity later. When the young man discovered the purpose of all this shifting from one department to another, he no longer was disturbed by the proceedings. He settled into each new place in an effort to learn the most he possibly could gain from the experience there. He took it all as a matter of schooling, as a matter of valuable information and experience on which to base his more important technical work of the future. But he narrowly missed resignation simply because he did not understand what it was all about.

Youth is inevitably impatient. It wishes progress at all times. The more spectacular the proceedings the more the young man likes them. Naturally, therefore, the beginner must see something in the future to inspire his present effort, or the work becomes merely drudgery.

It will pay to look around in every organization and find out if there are not some who are giving half-hearted or indifferent service simply because they do not understand what it all will lead to. The ambition and the impatience to be doing bigger and more responsible things are valuable assets not only to the young man, but to the organization by whom he is employed. However, these assets, to be conserved and capitalized to the good of the organization, must be supported by a measure of gratified ambition and still more by the prospect of larger things to come.

The National Board of Boiler Inspectors

WHEN a boiler arrives from a distance for installation in a state that requires all new boilers to be built according to the A. S. M. E. Code, how is the inspection department of the state where the boiler is to be installed to know that the boiler is up to the standard? Its compliance with the Code in most respects can be determined by inspection, but there are some particulars with which such compliance can be verified only by shop inspection during construction.

It is impracticable for a department to send an inspector to a distant state two or three times during the progress of a boiler destined for its jurisdiction. The natural thing would be for the inspection department of the several states to agree to accept the certificates of each other's inspectors.

And this is what is done, but with some safeguards. Governmental inspectors are sometimes appointed with more regard to the service that they have rendered at the polls than to their qualifications to pass upon the integrity and safety of boilers. The signature upon a certificate must mean somebody to the accepting department, and the certificate to which it is attached must without doubt apply to the particular boiler in question.

And so the chief inspectors of those states that admit boilers built in accordance with the Code of the American Society of Mechanical Engineers, have agreed among themselves that they will accept shop inspections made by inspectors whose character and qualifications are acceptable to them. And for the purposes of this and similar agreements and of examining into the antecedents and competency of inspectors and licensing or certifying to the acceptability of those found worthy and well qualified, they have organized the National Board of Boiler and Pressure-Vessel Inspectors.

When a boiler is completed, the manufacturer or his agent stamps it in the presence of an inspector who holds a certificate of competency from the National Board with the manufacturers' name or initials, a serial number and a symbol indicating that it conforms with the A. S. M. E. Code. The inspector signs a certificate to this effect, a copy of which is sent to the secretary of the National Board together with a copy of the boiler's data sheet, while duplicates of both certificate and data sheet go with the boiler and are presented to the inspection department where the boiler is installed. The state or local inspector, recognizing

the shop inspector as one of those who have been certificated, is justified in accepting the boiler as up to the A. S. M. E. standard, and there is no necessity of loading the boiler with a multiplicity of stamps to make it eligible in different states, as was necessary before this plan was adopted.

The National Board becomes in this way a sort of Register of Vital Statistics for boilers. Wherever a boiler may be found or whatever happens to it, if the stamp is still legible its record is available from the rolling of its plates to its approved completion and installation.

In order to make this service self-supporting, a fee varying from twenty-five cents for the smallest to three dollars for the largest boilers is proposed. If all the boilers built were registered, the intermediate figures could be largely reduced, for it is the purpose to collect only enough to cover the cost.

It would seem as though this were such a simple, cheap and effective solution of the inspection and stamping problems as to be eagerly availed of by all manufacturers of boilers that in quality conform to the A. S. M. E. Code. Were the Board an established institution with its permanency and efficiency assured, there would be no hesitation and the inspection and recording of boilers would naturally pass by this route. The only way to get the Board into this stable condition is to use and establish it. One of the prominent companies, in the light of its own investigations and the best legal advice that it can get, announces its own adherence to the system. Should the worst imaginable happen, the Board go completely to pieces and its records become dissipated, it is unthinkable that a boiler that had passed an inspector of record and conformed with the program here laid down would ever be condemned by a public official on the ground that it was not built in accordance with the Code; and if it were so condemned, that any court would sustain an inspection department in preventing its installation and use.

Obtaining Information

FOR information on his problems the engineer may read his technical paper, books, attend society meetings where his problems are discussed, meet salesmen and engineers of manufacturing companies and government and insurance companies' inspectors. If a representative of a manufacturing company is all that he should be, anyone interested in his product should be benefited by an interview with him. When the engineer knows his problems and the manufacturers' representative is familiar with all phases of his product, then it should not take long to find out the merits of the situation. However, too frequently neither knows his case and each tries to cover up his ignorance by talking generalities or reverting to an air of aloofness. Such tactics have led to failure many times where frankness and co-operation would have resulted in success.

Under the plant engineer's charge is much equipment that, if defective, is a hazard to life and property. Fortunately, much of this equipment is inspected periodically by government or insurance inspectors. Although in many plants this inspection may be only a check on what is already done, nevertheless there is proof of cases where these periodic inspections have prevented serious accidents.

There is a tendency on the part of many plant operators to treat these inspections with indifference, or as something that has to be tolerated. Instead of co-operating with the inspector, attempts are made to cover up defects and if successful to consider it a clever piece of work. In doing this an opportunity is lost to determine the thoroughness of one's own work. Where equipment such as boilers, engines, turbines and elevators, is involved, there is always the feeling, no matter how carefully they are inspected and maintained, that there may be a hidden defect, which may result in a serious accident. Open and frank co-operation with the outside inspectors is one of the surest ways of locating such defects if they do exist, and if they do not, a feeling of confidence is established.

With boilers more than with any other equipment, considerable preparation is necessary before a thorough inspection can be made. If the plant engineer is master of his own job, he has little to fear from the inspector or anyone else who may visit his plant, and may turn these visits into an opportunity to get an expert outside opinion on the equipment under his charge.

Knowledge Is Power

FACTS, figures, essentials, details, are increasing at an alarming rate. Knowledge is being sought, verified and utilized, in the power house, laboratory, drawing room, office and factory.

Competition sometimes compels secrecy, and it is often unwise to herald results before they are proved beyond criticism. Some disastrous experiences, such as occur in development work, tend naturally to create false impressions, in regard to motives and morale, since bad news frequently takes precedence over sober and well-balanced facts.

Sharing of knowledge, so that it may be acquired and applied whenever wanted, is characteristic of human progress and typical of engineering co-operation.

While it is at times difficult to secure information that would be of wide interest, the present tendency in manufacturing, public service and other enterprises is freely to co-operate in supplying information.

Knowledge begets confidence; secrecy fosters suspicion. Where a certain policy would require concealment, a broader and more up-to-date point of view often secures the benefits and good will of confidence and appreciation.

President Harding has set in motion a real effort not only toward ending the coal strike, but also toward preventing future troubles of the same kind. His methods have not the barefisted aggressiveness of Roosevelt, and his action might better have been started a little sooner; but the remedies adopted may, for these very reasons, be based on cool and more stable judgment, and the late date at which they are being discussed may spur both operators and miners to the quickest possible solution. Winter is around the corner, and the country's coal bins are empty; the President wisely recognizes this, and so his plan provides that work be resumed at once, while efforts to settle the dispute continue.

A motor may be of the highest grade and have correct characteristics for the service to which it is applied, likewise for the control equipment, but the whole installation can be made a failure by not being properly installed and maintained.

PRACTICAL IDEAS from PRACTICAL MEN

Accuracy Needed in Plant Cost Accounting

In many industrial power plants meters are installed for indicating and recording the pressure, steam flow, and CO_2 as well as coal weighers and watt-hour meters, from which a fairly complete report is made of the plant efficiency, the report being later sent to the office. Then what becomes of it? It may be carefully filed away by the file clerk, or someone may take note of the total amount of coal burned for the month and possibly the total kilowatts generated. But I have never seen an accountant copy off the engineer's carefully figured evaporation from and at 212 deg. or his figure for average boiler efficiency. Usually these mean nothing to him.

If the cost-accounting departments are for the purpose of recording costs in the several departments, why not have them accurate and complete?

Ask the salesmen who come in contact with the managers of many industrial concerns how many of these managers know anything about their power or boiler-room costs. Here are two cases from my own experience, and many other engineers could probably cite similar ones.

A certain plant used a large amount of steam in process work. Steam was being discharged to the atmosphere from pumps and condensate drains from which the steam traps had been disconnected or by-passed. All the machines used high-pressure steam direct from the boilers. Very little pipe covering was in use, and what was in place was disintegrated and had sagged so as to be of little value as a heat insulator. Later a low-pressure steam system was installed which collected the exhaust and utilized it in process work and for heating where live steam had formerly been used, and all piping was well covered. The result was that the engineer was called upon to explain why his costs for the last few months had gone up so high. He found that the piping, covering and labor had been charged to his maintenance account and he was unable to get it changed, for he had no authority to order material or direct the construction work. Consequently, the accounting department was unable to show any saving after the system was in operation.

In the second case the cost of the coal was carried on the books at the invoice price at the mine, which was about $1.40 per ton at the time. Freight and switching charges were about $3.25 per ton, but all freight was lumped together in the "general overhead." So in this case the records indicated about 30 per cent of the actual cost of the coal. Steam was being generated very cheaply until that was changed.

Sometimes a great deal of inertia has to be overcome before such methods can be changed. It means that all the carefully kept records of many years have to be gone over or scrapped, and this entails considerable work. The fact that some of our cost-accounting systems are inaccurate and incomplete may be partly due to the engineer not taking sufficient interest in them to find out whether the plant-operating costs are being properly accounted. Of course cost-accounting methods vary with different businesses; nevertheless there is in many cases room for a vast improvement in this direction.

When once the cost-accounting system is correctly established, the next thing is to get it connected up to the operating force so that it will register any change in efficiency. It should register the net saving effected by new equipment or accessories, such as CO_2 meters, feed-water regulators, feed-water purifying systems, etc. Then it is up to the management to furnish an incentive to keep the plant-operating costs at a minimum.

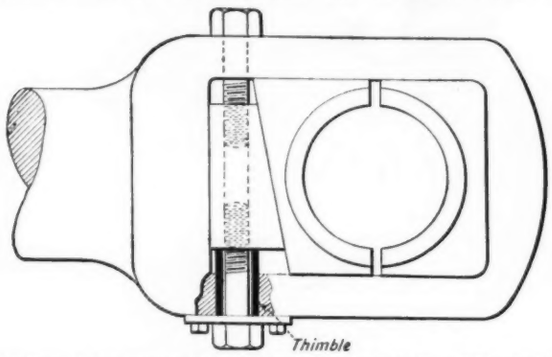
In general a furnace that is operated with good CO_2 and good efficiency will be harder on brickwork than one giving low CO_2 and low efficiency; also more difficulty will be had with clinker because of the higher furnace temperature. So unless there is an incentive, low CO_2 will be the rule, meters will fall into disuse and feed-water temperatures decrease while exhaust steam goes to the atmosphere and boiler efficiencies of 50 to 60 per cent will result. J. R. BELKNAP.

Lansing, Mich.

Support for Draw-Wedge in Solid-End Connecting Rod

The connecting rod of a horizontal ammonia compressor is of the solid end type, in which the brasses are adjusted by means of a wedge and draw-bolts. Twice in one week recently, the upper draw-bolt at the crosshead end snapped while the machine was running, thus allowing the wedge to drop and the brasses to become loose. In each instance there was considerable delay before a new bolt could be secured and put in place.

To prevent another shutdown on this account, the engineer adopted the device shown in the sketch. First, the hole through which the bottom draw-bolt passes was bored out $\frac{1}{16}$ in. larger. Next, a washer was made with just enough clearance to slip over the bolt and was fastened on with $\frac{3}{8}$-in. capscrews. The wedge was then drawn to the height necessary for the proper adjustment of the brasses, and the distance from the



WASHER AND THIMBLE PREVENT WEDGE DROPPING IF UPPER DRAW-BOLT BREAKS

washer to the bottom of the wedge was measured accurately. This distance was taken as the length for a thimble which was slipped over the bottom draw-bolt between the washer and the wedge.

With this device the wedge is prevented from falling in case the upper draw-bolt breaks. When it becomes necessary to draw up the wedge to compensate for the wear of the brasses, the thimble can be made snug again by placing a washer of the proper thickness beneath it.

A. J. DIXON.

St. Louis, Mo.

Unusual Case of Tube Blistering

Recently, the writer's attention was called to a rather remarkable case of tube blistering. A large industrial plant equipped with 60,000-sq.ft. vertical inclined water-tube boilers is supplied with a feed water that requires a special lime and soda treatment. The raw makeup water has the following impurities:

	Grains per Gallon
Calcium bicarbonate	7.41
Calcium sulphate	2.98
Magnesium bicarbonate	6.53
Sodium sulphate	4.26
Sodium chloride	3.97
Iron oxide and alumina	0.18
Silica	0.64
Organic matter	1.52
Total	24.49

A small amount of reddish-black scale is formed which is removed at convenient intervals.

When an increase was made in boiler capacity, it was found necessary to enlarge the water-purifying plant and for a time to use raw makeup water. A few days after the change in water was made, a series of tube failures started which did not stop until all the boilers had been thoroughly cleaned. The scale in the tubes, which was not over $\frac{1}{32}$ in. in thickness, had been loosened in large quantities and it was supposed that the failures were due to local accumulations in the tubes of this loose scale. A closer examination, however, disclosed some blisters with the original scale apparently undisturbed and without any sign of an accumulation of loose scale. Several of these blisters were cut open with a hacksaw, and it was found that the old scale had cracked and moved away from the tube surface under the action of the raw water. The cracks in the old scale were sealed up with a fresh accumulation of scale from the untreated water, the result being a patch of metal exposed to furnace temperature on one side and thoroughly insulated from the boiler water on the other.

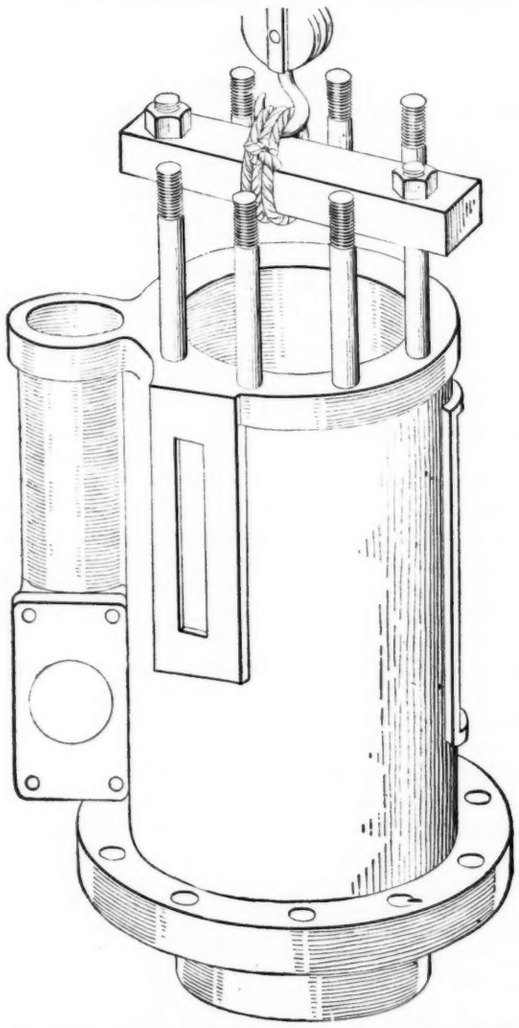
M. S. GEREND.

San Francisco, Cal.

Handling Engine Cylinders

Some time ago I was called in to help overhaul two oil engines. The chief engineer had had but little experience, and in removing the cylinders, which were to be rebored, he started to wrap a chain about the cylinder-head studs with the intention of looping the chain over the crane hook. I showed him that this would bend the bolts.

We then got hold of a 6 x 6 timber and bored two holes large enough and far enough apart to take two opposite studs. A sling was passed around the timber

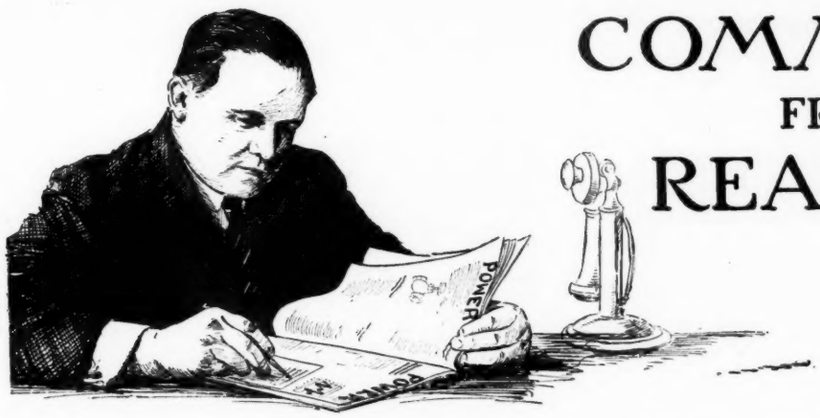


LIFTING CYLINDERS WITHOUT BENDING STUDS

and onto the crane hook as in the illustration. This arrangement is excellent, as all danger of bent studs is removed. The pull on the studs is vertical, and the cylinder will lift off the holding-down studs without any trouble.

J. SPREGG.

St. Louis, Mo.



COMMENTS FROM READERS

Increasing the Speed of Corliss Engine

With reference to the inquiry in the June 20 issue on means of increasing the speed of a Corliss engine, I have obtained the desired speed by lagging the governor pulley with a piece of belting of the proper width and length to fit the face of the pulley, and fastening it to the pulley with flat-head stove bolts. This increases the pulley size and causes the engine speed to increase before a corresponding position of the governor is reached. The proper diameter of the pulley was calculated before the work was done.

I have seen the same increase of speed accomplished on a flanged governor pulley by building up the diameter with ordinary hemp rope. J. B. FICKLEN.

Fredericksburg, Va.

Water-Column Valves

Commenting on the article in the May 30 issue on water-column valves, I recently took charge of a small, single-boiler plant and found that when I blew down the water column it took about ten minutes for the water level to come up again.

At the first opportunity I examined the column connections for the cause of the trouble. There were valves in the top and bottom connections. The top connection and valve were clear and in good order, but the bottom valve I could not stir, even with a 6-in. wrench. After letting the water down in the boiler, I removed the bonnet and found the valve almost completely plugged with scale, there being only the slightest opening through it. The piping from the boiler to the column was so badly scaled that it had to be replaced with new pipe. To do this, I had to break two cross-fittings and an elbow. As the firm claimed brass pipe was too expensive, I was obliged to use iron pipe, which is forbidden by New York State laws.

In my opinion brass pipe and a gate valve should be used in each connection, but should be kept in good order by frequent inspection and repairs when needed. When allowed to become plugged as in this case, it produces an element of danger for those around the plant and endangers the reputation of the engineer.

Rochester, N. Y. R. G. SUMMERS.

I came across a boiler installation not long ago where the boiler feed was connected into the steam connection of the water column close to the shell of the boiler. This connection was changed, however, before the boiler was operated.

Mr. Spooner speaks of losses that may take place and would take place should these valves be closed for any length of time. The instructions I received in my early training in boiler operation were to this effect: You should blow your column out frequently, and to do so and be sure it is clear, first close the valve in the water connection and open the drain valve, then close the steam valve and open the valve in the water connection, and blow down again. By doing this you can be absolutely sure that the connections to the boiler are clear.

If you cannot depend on a man to see that the valves are open, can you depend on him to blow down or try the gage cocks? E. E. KIRTLEY.

Fredericktown, Mo.

Higher Steam Pressures

I read with interest the editorial in the June 6 issue on "Higher Steam Pressures." I believe, however, that this is one branch of engineering where consulting engineers should make haste slowly. I do not think the designing engineer has as yet reached the point where he can cope with all the difficulties arising from superheated steam at the temperature mentioned, 700 to 750 degrees.

If a pipe is heated to 750 deg. and placed in a dark room, it will have a dull-red glow. At this temperature the metal has lost some of its tensile strength, and with a pressure of 500 lb. we can look for trouble.

Two years ago I was on a turbine job in Texas, where the customer was having trouble with the governor. When the main generator switch would trip out, with the turbine at full load, the turbine would overspeed and the emergency governor would trip. When operating on load it would speed up and slow down, causing a zigzag line on the recording flow-meter chart. Upon examination of the turbine-governor valves while running, it was found that they were sticking, causing the governor to hunt. When the turbine was shut down and before the valves could be disconnected, the steam chest had cooled down considerably and the valves were perfectly free. I then took the temperature of the steam and found that it was 625 deg. The steam chest was of cast iron, and the unequal expansion would cramp the valve cages and cause the governor to hunt. The turbine was designed for operation with steam having around 100 deg. superheat. The engineer in this plant was having all kind of trouble with auxiliaries as a result of the superheat, none of them having been designed for this high temperature. The plant was designed and constructed by one of the best-known firms of engineers, and the equipment was of the best.

Lookout Mountain, Tenn. L. LONG.

Making Ammonia Compressors Safe

Mr. Crawford, in his comments, which appeared in *Power*, June 6, upon the article "Making Ammonia Compressors Safe" in the May 9 issue, says that it is impossible to replace heavy poppet valves with light plate valves in slow-speed ammonia compressors.

"It cannot be done" is the old, old story of the less progressive in every field of activity. But every time along comes the fellow who does it. It is only a matter of going at the thing in the right way. Had Mr. Crawford taken the trouble to investigate the question more thoroughly, I am quite sure he would not have written down his hasty statements. All the figures he gives are wrong and, therefore, may mislead refrigerating engineers.

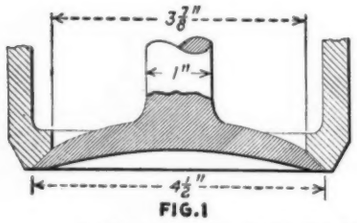


FIG. 1

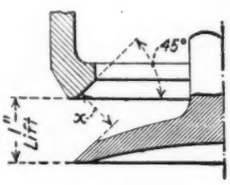


FIG. 2

FIGS. 1 AND 2. POPPET-VALVE DIMENSIONS

Now let us see how and why. Fig. 1 is a layout of a 4½-in. suction poppet valve with an over-all valve-body dimension of about 5 to 5¼ in. The valve disk is 4½ in. at its greatest diameter and 3⅞ in. at the smallest diameter, and the seat is beveled under 45 deg. as usual.

The largest ideal passage area is, then, the area of the port minus the valve-stem area. The area of the 3⅞-in. diameter valve less the area of the 1-in. stem equals 11.793 — 0.785 = 11.008 sq.in. and not, as Mr. Crawford says, 15.9 sq.in. The difference is about 5 sq.in. Surely 11 sq.in. is the largest possible seat area under ideal working conditions.

The next thing that Mr. Crawford has overlooked is that the seat of the valve is beveled under 45 deg. and that this reduces the *ideal* area still further. How much this reduction is, is shown in Fig. 2. With 1-in. lift, which is about correct for a 3⅞-in. diameter valve, the width of the channel, which controls the *ideal effective* passage area, is then the lift times the cosine of 45 deg., or 1 × 0.7. The ideal effective area is then the circumference of the 3⅞-in. diameter valve times the effective lift, or 12.17 times 0.7 equals 8.519 sq.in. This is only about half the area that Mr. Crawford thinks he can locate in a 5-in. over-all valve pocket.

This is getting smaller and smaller, but we are not yet at the end of the area-reducing process. There are other handicaps under which the heavy poppet valve works in practical working conditions, as follows:

a. The maximum lift of 1 in. is obtained only at the very short moment of the highest piston speed.

b. The valve opening and closing are hampered by chattering, and this reduces the ideal working area to a great extent.

c. Finally, we have the resistances to be overcome, and these are the weight of the valve, the spring tension and the pressure difference resulting from the unbalanced area.

All these influences together reduce the ideal effective valve area by at least 40 per cent so that the true effective valve area is only 60 per cent of 8½ sq.in., which results in an effective valve area of 5.0 sq.in. This is the area that counts for the admission of the gas to the cylinder. It is seen that the effective area is just about one-third of Mr. Crawford's figure.

Now then, why make such a heavy and unsafe valve when it does not give more area than a light plate valve? Is it not common sense to use a light valve and have it safe, instead of taking a chance with an unreliable valve?

But even if a light plate valve has a smaller area it is much preferable because (1) its area is instantly available to its full size, (2) its area stays available during the whole of its working period, (3) its resistances are very small, (4) it costs less and is easier replaced, and (5) it is absolutely safe.

Besides these the light valve has other advantages, such as noiseless operation, the absence of adjustments and grinding of the seats.

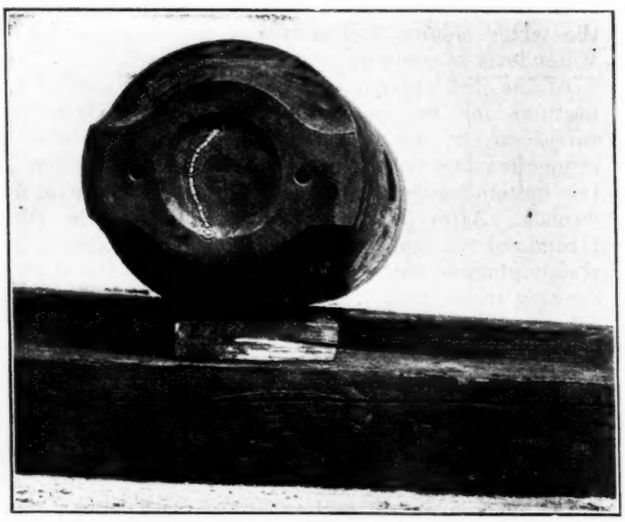
J. H. H. Voss.

New York City.

Sewing Oil-Engine Piston

About six months ago I asked *Power* as to the best method of repairing quickly and cheaply a fracture in the top of an oil-engine piston. Acting upon the advice given, I proceeded to drill and top all along the fracture a series of ⅜-in. holes, spaced approximately ¾ in. apart. Plugs made of wrought brass rod were threaded and screwed into these openings. A second row of ⅜-in. holes were drilled between and taking in part of each pair of plugs. Plugs were inserted in this and the entire row was hammered flat.

The piston was put into service and ran for six months without any trouble. Upon removal after this time, the head appeared as in the illustration. It will be noticed that the plugs are slightly eaten away at the



SEWED FRACTURE OF OIL-ENGINE PISTON

sides. This is due to the fact that they were cut off a little too long and in riveting or hammering them the edges became quite thin. The high temperature in the cylinder then caused the thin parts to burn and fall off.

The fracture, after sewing, never showed any signs of opening up, and in my opinion this "sewing" is equal to welding on small pistons and is much cheaper. Its chief merit is that it can be done quickly and by any engineer.

J. Toney.

Bracketsville, Tex.

When Is a Trap Leaking Steam?

An article on steam traps, by E. Smiley, in the July 11 issue of *Power* emphasized the point that a discharge of steam from the outlet of a trap does not prove that the trap leaks, since some steam normally results from the flashing of hot water into steam upon the release of pressure. On page 47 Mr. Smiley showed how to test for trap leakage. This test consists, in brief, of passing the discharge of the trap into a pail or barrel containing cold water, noting the original weight of cold water, the increase in weight and the original and final temperatures. Then the heat given out by the trap discharge in falling to the final temperature is equal to the heat gained by the cold water in rising to the same temperature. Knowing the two weights, it is possible to use the steam tables to find out whether the weight of the actual trap discharge, figured as all water, is enough to account for the temperature rise that takes place. If not, some steam must have leaked through.

There seems to be no way of avoiding the experimental part of this test, but the use of the steam tables and practically all the computation can be eliminated by using the accompanying diagram, which I have prepared. The use of this diagram is best illustrated by a practical example. A pail containing 40 lb. of water at 76 deg. F. is placed on a platform scale. The trap is allowed to discharge beneath the surface of the cold water until the weight increases to 60 lb. The temperature of the water is now found to be 140 deg. The steam pressure on the trap is 10 lb. gage. Does the trap leak steam, and if so how much?

To solve this, the first thing to do is to draw the light line *a* from the steam pressure (10 lb.) on the upper left scale to the initial water temperature (76 deg.) on the right scale. Then draw another light line *b* from the final water temperature (140 deg.) on the lower left scale to the same temperature on the right scale. These two lines *a* and *b* intersect at the point *c*.

Now the weight of the water in the pail increased from 40 to 60 lb., an increase of 50 per cent. Note the relation of the vertical line called "50 per cent increase in weight," to the point *c* and the lines *a* and *b*. Point *c* falls to the left of the 50 per cent line, which means that the trap is leaking steam. Theoretically, for a trap that does not leak steam and at the same time does not lose any heat by radiation, the point *c* ought to fall directly on the vertical line corresponding with the per cent increase in weight. In practice it should ordinarily fall a little bit to the right, because the water in the trap is somewhat cooler than the steam.

Returning to the case in hand, it is possible not only to tell that the trap leaks, but to get an approximate idea of how much it leaks. Note the distance *d* included on the 50 per cent line between the points where the lines *a* and *b* cut it. Take off this distance with a pair of dividers or a slip of paper and slide vertically down the 50 per cent line to the special scale at the bottom of it. This shows that about 3 per cent by weight of the trap discharge is leaking steam.

The use of this diagram should be much more rapid than that of the steam tables, and sufficiently accurate for all practical purposes.

Boston, Mass. L. R. ROWE.

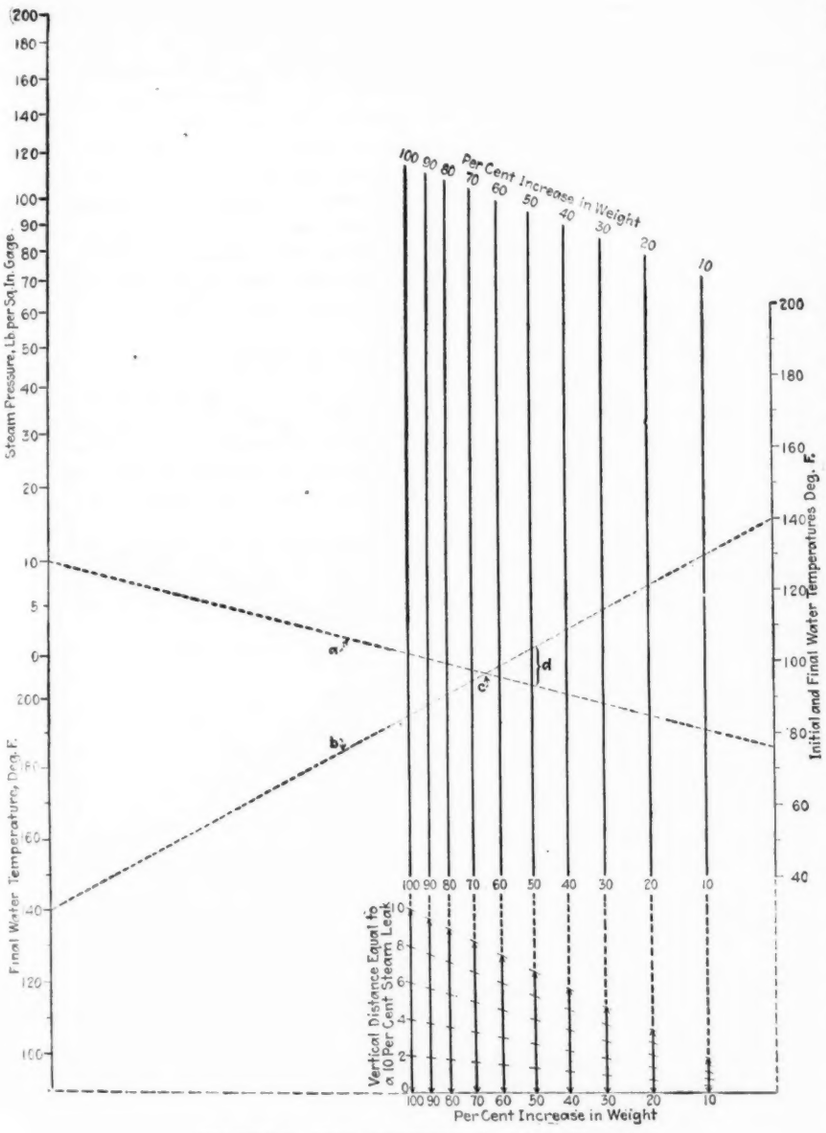

Steam Pressure, Lb per Sq In Gage
Final Water Temperature, Deg F.
Initial and Final Water Temperatures Deg. F.
Per Cent Increase in Weight
100 90 80 70 60 50 40 30 20 10
a
b
c
d
Vertical Distance Equal to a 10 Per Cent Steam Leak
0 2 4 6 8 10

DIAGRAM FOR FINDING TRAP LEAKAGE

Peter Brotherhood, Ltd., of England, has brought out a cold-starting medium compression engine which, so the maker states, will run on any fuel that can be pumped. The most startling piece of information is that these engines have been run on sewage grease from town sewers. This grease is in the form of a thick paste when recovered by treatment and requires warming before reaching the engine fuel pump. Apart from provisions for heating, no alteration in the engine was needed to burn the grease.

QUESTIONS AND ANSWERS

Water Delivered by 2-in. Pipe Line

We intend to install a water-pipe line having a length of 2,500 ft. with a head of 450 ft. There will be one bend in the line. How many gallons per minute will the pipe deliver? N. C. G.

With the inside of the pipe smooth, without burrs or contractions at fittings and of full size throughout its length, and the entrance of the pipe submerged about 4 ft., the pipe line should deliver about 78 gal. per min. at atmospheric pressure. By throttling the discharge to a delivery of 75 gal. per min., the pressure would be about 19.5 lb. per sq.in.; 70 gal., 50 lb. per sq.in.; 60 gal., 83 lb.; 50 gal., 130 lb.; 40 gal., 151 lb.; 30 gal., 168 lb.; 20 gal., 180 lb.; 10 gal. per min., about 190 lb. per sq.in. The static pressure, or pressure without any discharge taking place, would be 194.8, or practically 195 lb. per square inch.

Drying Out a Direct-Current Generator

A 220-volt compound-wound direct-current generator had its windings water-soaked, and it was decided to try drying it out by short-circuiting the machine. Additional resistance was connected in series with the shunt-field winding and the machine started, but before it could be got up to full speed the current became excessive and tripped the circuit breaker. The shunt-field circuit was opened and the machine started again, but with no better results. The next move was to cut the series winding out of circuit and connect the shunt winding in. With this arrangement it was possible to maintain the short-circuit current at about 125 per cent full-load value, but the machine sparked quite badly. What was the cause of the circuit breaker opening and the machine sparking? M. E. W.

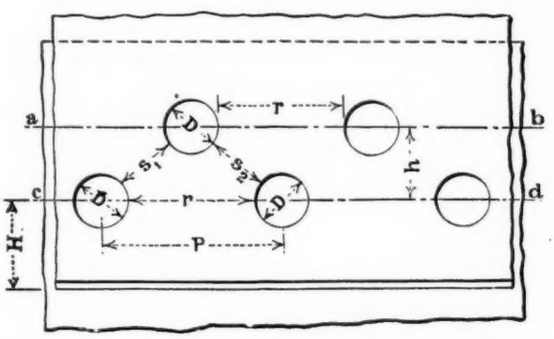
With the series winding in circuit the machine was operating practically the same as a short-circuited series machine. As the current increased, it increased the strength of the series field flux, which in turn increased the voltage of the machine, and the building-up process went on until the current reached a value where the circuit breaker opened. It is probable that the brushes were set back of the neutral, and this would tend to assist in building up the voltage. If the brushes had been located ahead of the neutral, it is doubtful if the machine would have delivered full-load current on short-circuit with the series winding in alone, since under such conditions the armature poles tend to demagnetize the main poles.

To reverse the current in the armature coils under commutation without sparking at the brushes requires that these coils have a voltage generated in them of a direction to assist in reversing the current. When the machine is operating at full voltage, they are excited to a strength where a sufficient commutating flux is provided from the pole tips. But when the machine is operating at low-voltage, the main poles are excited to only a low value and a commutating flux probably does not exist at all. In fact, the armature pole may produce a flux that will generate a voltage in the coils under commutation which will oppose the reversal of the current instead of assisting the change. Either one of these conditions will produce sparking—the latter of a more severe character than the former.

Back Pitch

In a staggered riveted joint what should be the distance between the parallel rows of rivets to prevent tearing of the diagonal ligament between rivet holes before tearing takes place between the rivets of the same row; and how much should the sheet lap outside of the rivets? R. N.

It has been well established by experiment that if 30 per cent more tearing area is placed on the oblique lines s_1 and s_2 than along r, the distance shown in the figure



from rivet to rivet of the parallel rows, rupture will be confined to material between rivets of the same row. Therefore the approximate relation would be $\frac{s_1 + s_2}{r} = 1\frac{1}{3}$.

The A. S. M. E Boiler Code provides that the distance h or "back pitch" measured at right angles to the direction of the joint, shall have the following minimum values:

(a) If $\frac{P}{D}$ is 4 or less, the minimum value of h shall be $2D$;

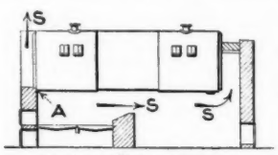
(b) If $\frac{P}{D}$ is over 4, the minimum value shall be: $2D + 0.1(P - 4D)$.

The A.S.M.E. Boiler Code provides that on longitudinal joints the distance H from the centers of rivet holes to the edges of the plates, except rivets holes in ends of butt straps, shall be not less than $1\frac{1}{2}$ and not more than $1\frac{3}{4}$ times the diameter of the rivet holes.

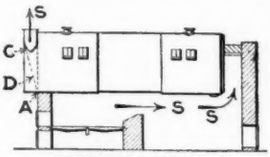
Flush-Front and Overhanging-Front Boiler

What are the relative advantages of flush front and overhanging front for the setting of horizontal return-tubular boilers? L. H. B.

The flush front setting, Fig. 1, may be regarded as making a better appearance, but has the defect of difficulty in maintaining a good seal between the top of the front furnace wall and the under side of boiler shell at the point *A*, to prevent the escape of hot furnace



FLUSH-FRONT SETTING
FIG 1



OVER-HUNG SETTING
FIG. 2

gases direct to the front connection in place of traversing the full length of the boiler and returning through the tubes, as indicated by the arrows *S*, *S*. The seal at *A* can be increased only by making the front furnace wall thicker with correspondingly greater length of the fire-door arch, or by encroaching on the depth of the front connection. With an overhanging front the front smoke connection is formed, as shown in Fig. 2, by an extension of the boiler shell beyond the arch front. The furnace seal at *A* is of the full thickness of the front wall, a narrower fire-door dead plate and shorter arch are permissible, and failure of the seal results in no greater harm than to admit air to the furnace. For very low settings the overhang may be regarded as an obstruction to the fireman, but this objection is overcome by sloping the front end and cleaning doors, as indicated by the dotted line *CD* Fig. 2. With the overhanging type of setting a little more of the heating surface of the shell is stopped off by the top of the front furnace wall than in the full flush front setting, but this is more than compensated by greater convenience in firing through doors in a thinner wall, no loss of heat direct to the stack, and less annoyance and expense of repairs from failure of fire-door arches and furnace walls.

Setting Adjustable Riding Cutoff

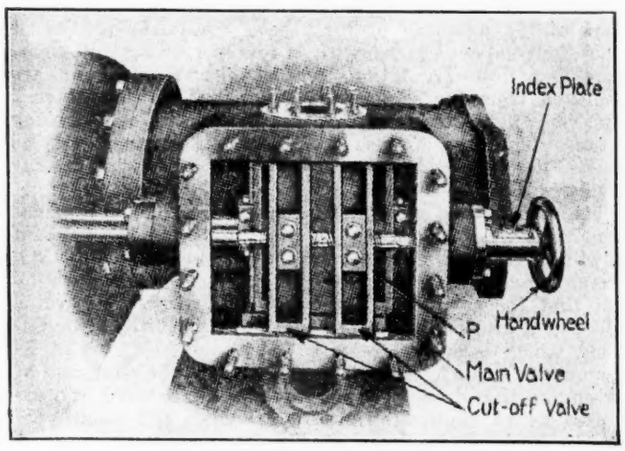
How can I set the adjustable riding cutoff valve of a steam-driven air compressor? H. G.

The illustration shows an adjustable riding cutoff with the steam-chest cover removed to obtain a view of the main valve and cutoff valves, which operate substantially the same as the adjustable riding cutoff illustrated and described on page 67 of the July 11 issue. It is to be borne in mind that, in the arrangement referred to the lead, release and compression are controlled solely by the main valve, which is an ordinary D slide valve, having each end extended with a port *P*. When cutoff is performed by the cutoff valve, it is accomplished by the outside edges of the cutoff plates covering the ports in the main valve.

To set the valves, first remove the steam-chest cover; turn the handwheel to bring the cutoff valve plates as near together as they can be adjusted with the handwheel, and temporarily set the cutoff eccentric about opposite to the crank. First set the main valve exactly as with a plain D slide valve, remembering that the admission is controlled by the port edges that are nearer the middle of the valve. Place the engine on a center and swing the main eccentric in the forward direction around on the shaft until there is about $\frac{1}{32}$ in. opening or the desired lead on the end that should receive steam. Then place the engine on the other dead center and correct any inequality of lead, taking up one half by adjustment of length of the main valve rod or eccentric rod and the other half by readjustment of the setting of the main eccentric, and repeat the adjustments with the crank on first one and then the other dead center until the desired leads are obtained.

After the main valve has been set, place the crosshead at one-half stroke, turn the handwheel to obtain registration of one-half cutoff on the index plate and swing the cutoff eccentric forward around on the shaft until the cutoff plate just covers the port *P* on the end open to the cylinder. Then turn the flywheel forward past the dead center and place the crosshead at one-half stroke from the other end, observing whether the outside edge of the cutoff plate has just closed the port in the main valve. If more or less than just closed, correct one-half of the amount by adjustment of the cutoff valve rod, or cutoff eccentric rod, and the other half by setting the cutoff eccentric to obtain closure of the valve when the eccentric is swung around the shaft in the forward direction of rotation. Then turn the flywheel forward until the crosshead comes to one-half stroke from the other end and repeat the adjustments first from one end and then from the other, until cutoff is obtained at half-stroke from both ends.

After thus adapting the cutoff valve setting to the position occupied by the main valve when the piston is at one-half stroke, set the handwheel to



registration of one-fourth or any other fraction, and place the crosshead at the corresponding fraction of the stroke first from one end and then from the other end. It will be found that the cutoffs are slightly unequal on account of the angularity of the connecting rod, and the nearest to equality that can be obtained with the given setting of the main valve is to take out one-half of the difference by resetting the cutoff eccentric and thus divide the inequality between $\frac{1}{4}$ and $\frac{1}{2}$ cutoff.

If it is desired to have the cutoffs correspond more nearly with the registrations of the index plate, set the handwheel to the most used fraction of cutoff and place the crosshead at the corresponding fraction of stroke from either end. Then adjust the main eccentric to cover one-half of the error and make the balance of the correction, one-half by moving the cutoff eccentric and one-half by adjustment of the cutoff valve rod or eccentric rod.

Service in Federal Buildings*

By NELSON H. THOMPSON
United States Treasury Department

THE office of the Supervising Architect of the Treasury Department is particularly fortunate in that it has exclusive jurisdiction over the design, construction, operation and repair of the various buildings it erects, and also has exclusive jurisdiction over the personnel of the operating forces as well as over the purchase and use of all supplies, etc., required for the various buildings. That this situation is correct and logical is shown by the extraordinary economies that have been effected since steps were taken to place all these responsibilities under one technical bureau, instead of entrusting them to several related or non-related bureaus, as was previously the custom in the Treasury Department.

In the Federal buildings (not hospitals) under control of the Treasury Department there is burned about 125,000 tons of coal per annum, made up of approximately 28,000 tons of anthracite (small sizes), and the rest bituminous. About one-half of the coal is bought locally and the remainder direct from the mines. The total cost of this coal, delivered in the bins, is approximately $1,000,000.

The purchase of other supplies needed for the operation of the mechanical plants is largely standardized, especially in the matter of electric-light bulbs, of which about $125,000 worth are used per annum. Each building requires approximately one new lamp for each socket per year, as the light is used about 1,200 hours.

High Efficiency Necessary

To compete with the large central plants, it is necessary to install engines and generators of the highest efficiency consistent with reasonable first cost, and this led in the past to the adoption of high-speed non-releasing Corliss type four-valve engines with a low percentage of clearance and close regulation, because electric elevators are operated from the same busbars as the lighting systems, and very little flickering of lamps is tolerated. In any future plants the highest-grade unaflow engines will be used in lieu of the four-valve engines, on account of greater economy and lower first cost.

The engines and generators are purchased on the valuation system, which means in effect that the Government is willing to make a substantial investment in steam- and current-producing apparatus if it can be demonstrated by test that the saving per annum of the costlier apparatus will pay a dividend of 15 per cent on the additional investment, which is always required when the first cost of an economical steam engine is compared with the first cost of an engine that is not economical but is marketed and exploited as an engine. High-grade boilers and smoke-consuming furnaces are installed; the plants are too small as a rule to warrant the use of stokers.

Engineering Labor Is High

In connection with the operation of isolated electric generating plants of twenty-four hour activity, the cost of engineering labor is high compared with that of labor in commercial plants of ten-hour activity, and it is worthy of note that by careful operation and close supervision it has been possible in some instances to compete with large central stations, except where certain influences have made the labor item excessive. In some of the plants that have been shut down in recent years the principal cause of the change has been that the engineering employees have overreached themselves in the matter of hours of labor, rates of pay, etc., coupled with the fact that the plants themselves were old and generally low in all-around efficiency.

Generally speaking, an isolated plant begins to be feasible in a Federal building when the full connected load is not less than 150 kw. and when the annual current consumption is not less than 200,000 kw.-hr., and the cost of current from the central station is not below 4c. per kw.-hr. It is pertinent to state that while every isolated electric generating plant so far installed under the personal direction of the writer has been a paying proposition, the economic conditions have not warranted the installation of such a plant in a Federal building during the last six years.

To obtain data upon the operation of buildings under control of the Treasury Department, records are kept in some detail, especially for the larger buildings, and these records and data are studied, compared and used as guides in the design of new projects, or when consideration is being given to the purchase of steam and electricity and the shutting down of an isolated plant in a building.

All the important buildings containing electric generating plants are equipped with coal scales, steam-flow meters, water meters, etc., and the chief operating engineers are provided with daily report blanks covering the coal consumption, ash removal, steam consumption, etc., of the generating plants.

Comparison of Costs

In old buildings where a boiler plant is in operation to supply steam or hot water for heating alone or for heating as well as the operation of a generating plant, the actual cost of labor, fuel, ash removal, repairs, etc., as well as all the operating characteristics of the building, are taken from the records for comparison with the rates offered for similar service by the local utilities company, when the question arises as to whether the manufacture of steam or electricity, or both, is to be continued, or whether the plant is to be shut down in part or in toto and the service purchased from the utilities company.

Generally, the public-utility company is expected to make a figure that will result in an annual saving of at least 10 per cent over what it costs the Government to provide itself with steam and electricity.

If a district heating system is in operation in a city in which a Federal building is to be erected or remodeled, the heating apparatus is so designed that it may be operated either from the mains of the district heating system or from boilers installed in the building. The boilers are always installed, to serve as a check on the cost of outside service and for use in case of breakdown in the district system; but usually it is equally economical and generally more satisfactory to purchase steam or water for heating than to generate it in the boilers provided.

Economy Dependent on Saving in Labor

As a general rule there must be a saving in labor due to the purchase of steam or water if any economy is to be effected over the operation of the boiler plant. In the smaller buildings no saving in labor can be effected, as the operating forces of these buildings are small and receive almost incredibly small wages, and are required not only to fire the boiler but to perform the work of cleaning the building.

In order to compare the prices quoted for steam or water for heating with the cost of generating the same in the boilers provided, it is the practice to multiply the square feet of direct heating surface by 500 to ascertain the number of pounds of steam condensed per annum in the system, and divide the result by 7 to ascertain the number of pounds of coal required in the boilers. This information, together with the local price of coal delivered in the bunkers, cost of labor for firing (if any), and the rates for steam quoted by the local district heating company furnish all facts in the case and render possible a decision on the merits of each proposition. If water is the heating medium, the calculation is based on an equivalent of 300 lb. of steam per square foot of radiation per annum. If oil or gas is used as fuel in lieu of coal, these are reduced to the equivalent coal basis by assuming that three

* Abstract of paper presented before National District Heating Association, Cedar Point, Ohio, June 20-23, 1922.

barrels of fuel oil or 20,000 cu.ft. of natural gas equal one ton of bituminous coal.

In arriving at the monthly consumption of steam, the accompanying table is used.

	Per cent.
October	6
November	10
December	18
January	18
February	18
March	15
April	10
May	5

This table is also used in ordering the coal delivery to the building when the bunker capacity is not sufficient to store a season's supply.

In case of a new building of the larger size, consideration is given to the purchase of electricity versus the installation of an isolated electric generating plant, and in analyzing the situation the following basic data are used:

The total cubic contents of the building multiplied by four is assumed to equal the total pounds of steam per annum for heating and ventilating the building.

The average demand for steam per hour for heating and ventilating equals the annual consumption divided by 5,000.

The maximum demand for steam per hour for heating and ventilating is 2½ times the average demand.

If the heating surface is known, the blast coils are reduced to equivalent direct radiation by multiplying the square feet of heating surface in blast coils by three; and after all surface is reduced to equivalent direct steam radiation, to ascertain the total steam required per annum, the number of square feet of equivalent direct steam radiation is multiplied by 500. This is used as a check on the first assumption, and the mean of the two quantities is generally taken.

Gravity indirect water or steam radiation is reduced to equivalent direct water or steam radiation, as the case may be, by multiplying by 1½.

To reduce direct hot water to direct steam equivalent, it is divided by 1.6.

Car miles per day for each elevator in an ordinary small Federal building are taken at 5; while in the large buildings of six or eight stories, in places like New York and Philadelphia, and in the departments at Washington, each passenger elevator will average 10 car miles per day.

Kilowatt-hours per car mile for electric elevators equal 5.

Steam per car mile for hydraulic elevators operated by compound duplex steam pumps equals 1,000 lb., while for high-duty pumps it amounts to 650 pounds.

Steam per annum used for heating water for sanitary purposes is 10 per cent of the total steam used for heating and ventilating the building.

For a post-office building of 24-hour activity the annual current consumption in a modern large Federal building will average 2½ kw.-hr. per square foot of total floor area; while in a large modern Federal building of 8-hour activity it will average 1¼ kw.-hr. per square foot.

In Federal buildings of 1,000,000 ft. cubic contents or smaller, with 24-hour service and electric elevators, the current consumption per annum will average 0.8 kw.-hr. per square foot of total floor area.

The average demand for electric power and light will be the total annual consumption divided by 8,760, and the maximum demand will be 2½ times the average demand in a 24-hour building, and four times the average in an 8-hour building.

If an electric generating plant is installed in a building, using high-grade four-valve engines, 50 lb. of steam is allowed for each kilowatt-hour generated, on the switchboard, with 80 per cent allowance for the exhaust into the heating system during the winter.

To reduce the pounds of steam to coal, an average evaporation of 8 to 1 is assumed for bituminous coal in the larger plants, 7 to 1 in the smaller plants and 6 to 1 for anthracite pea or buckwheat coal.

Boiler-room repairs amount to $1 per horsepower of nominal horsepower rating.

Engine-room repairs are $1 per kilowatt of nominal total kilowatt rating of generators.

Boiler and engine-room supplies approximate $2 per kilowatt of generator rating.

Boiler-room labor averages $2 per ton of coal fired, which is based on an 8-hour shift and an average wage per day of $2.50 for each fireman. In the smallest generating plants one chief engineer at $1,400, and three assistant engineers at $1,200 each per annum must be provided, and in the larger plants the salaries are increased and additional labor supplied.

The labor in a Federal building containing an electric generating plant will roughly average the same as the cost of the coal, supplies and repairs to the boilers and electric generators. The fixed charges for machinery are 5 per cent interest and 5 per cent depreciation per annum on engines, boilers, etc., while on buildings, tunnels, sea walls, cables, etc., 2 per cent depreciation per annum is allowed.

The annual dividend that must be earned by the ordinary isolated Federal plant in comparison with the purchase of current from a public-utility company, is 10 per cent on the cost of the Government plant.

Permit Granted for Big Columbia River Project

The Federal Power Commission has authorized the issuance of a preliminary permit for three years to the Washington Water Power Co. for a power project at Kettle Falls in the Columbia River. The ultimate installation is estimated at 153,400 hp. The company proposes to develop the project in three stages correspondingly as a market for the power can be found. In the initial development it is proposed to use the natural fall of about 30 ft. at Kettle Falls. As the demand for power increases, additional capacity will be provided by building a 60-ft. dam across the Columbia River. The height of the dam may later be raised to 75 feet by the use of gates.

The Commission has also authorized the issuance of a preliminary permit to the Northern States Power Co., of Minneapolis, Minn., for a period of three years for the development of two power sites in the Mississippi River at Otsego and Monticello, Minn. The dams at these sites will be approximately 30 ft. high and will develop all the head between St. Anthony Falls and Clearwater, Minn. Approximately 10,300 hp. of primary power will be available at the two sites.

Another permit was authorized for issuance to the St. Cloud Public Service Co. for a power site near Clearwater, Minn. The proposed dam will be approximately 30 ft. high and will develop 4,500 hp. of primary power. An application for this site was made by the Northern States Power Co., which did not propose immediate development, whereas the St. Cloud Public Service Co. has immediate need for power.

A preliminary permit for a power development on Cascade Creek within the Tongass National Forest, approximately 22 miles north of Petersburg, Alaska, was authorized for issuance to F. L. Hutton, F. W. McNear and F. C. Dougherty, of San Francisco, Cal. Utilization of Swan Lake as a reservoir is contemplated. The project will consist of a dam to be constructed at the outlet of the lake, a conduit consisting of a tunnel and pipe sections, and a power house to be located on the shore of Thomas Bay. An initial development of 16,000 hp. is contemplated.

Four applications for permit or license under the Federal Water Power Act were filed with the Commission during the four weeks period ended July 8, making a total of 322 applications received to that date. One was filed by the City of Louisville, which made application for power development at the proposed reconstructed dam in the Ohio River at the Falls of Louisville, in Louisville, Ky. The city proposes to use the power for municipal purposes and to sell it for public-utility purposes in Louisville and adjacent municipalities. The application is in conflict with an application for a preliminary permit from the Louisville Hydroelectric Co. The details of the plans of these two applications have not yet been worked up, but the project will have an installed capacity of about 90,000 horsepower.

News in the Field of Power

Engineers Honor Marconi for Bringing Nations Together

The recent meeting at which Senator Guglielmo Marconi was presented with the John Fritz medal for his discovery of wireless was marked by a record attendance, by unusual enthusiasm and by the recognition, in the various speeches, of the far-reaching effects of wireless in annihilating distance and so bringing the nations of the world into closer and more friendly relations.

The affair was held in the Engineering Societies Building in New York City, and followed directly after a dinner given to the inventor by the John Fritz Medal Board of Award, representatives of the four founder societies, several former medallists and a number of men prominent in engineering and other activities. Prof. Comfort A. Adams presided over the meeting and explained the purposes of the award.

"The profession of engineering," said Prof. Adams, "knows no national boundaries. That the engineers of this country sense this fact deeply is evidenced by the absence of any limitations as to nationality in the award of the John Fritz medal." He went on to say that engineering discoveries such as wireless are breaking down the barriers of distance between nations and so helping to create a condition in which intelligent co-operation will be a necessity and war an impossibility.

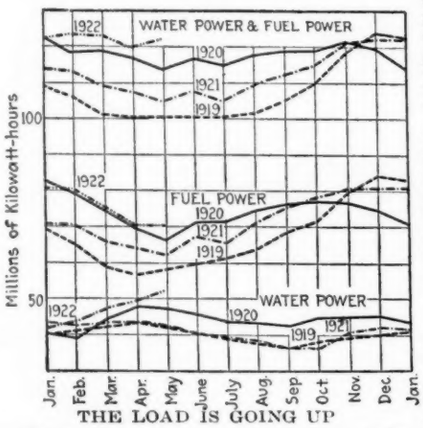
Senator Marconi stressed the same point in his speech of response in these words: "I consider myself fortunate that much of my early work in radio has been carried out in this country, for I cannot help feeling that you realize that wireless communication has become useful and often necessary on sea and on land, besides tending to increase and simplify the facilities for closer communications between distant peoples on this earth, thus contributing, I hope, to make goodwill take the place of the unrest and mutual suspicion which unfortunately seems at present to be a dominating feeling amongst many nations."

James R. Sheffield, president of the Union League Club, and for twenty years a personal friend of Marconi, eulogized the inventor and stressed the importance of his work, saying in part: "And what a benefactor to the human race he has been! In the domain of business and commerce, in the saving of human life, in the addition of pleasure and comfort and happiness to millions of human beings, the work of that quiet student at his father's home in Italy has grown into one of the most marvelous blessings conferred upon the world even in this, the golden age of discovery and science."

Prof. Michael I. Pupin, of Columbia University, and himself a medallist, spoke with characteristic eloquence and, in closing, delved into the future with this thought: "Who will deny the possibility that before many years have passed the word spoken in this great engineering hall will be heard in every other engineering hall on the face of this terrestrial globe. The human mind is bigger than this terrestrial globe, and knowledge is an instrument which can cut its way through any temporary limitation of time and space. Such a knowledge exists now in the new science of electrical transmission. It is the growth from the seed which Senator Marconi dropped into a fertile field. The toilers in this field are many and the world rejoices in the fruits of their toil."

Power Load Shows Industrial Activity

A report recently issued by the Geological Survey, giving statistics on the production of public utility power plants up to the end of May, shows that in that month there was a decisive increase in the combined water power and fuel power load. The rise is shown clearly at the top of the illustration above; it may be seen that the curve bears out reports of increasing industrial activity.



THE LOAD IS GOING UP

These curves show the average daily production of electricity by water power, fuel power, and both together, in central stations of the United States, from the beginning of 1919 to the end of May, 1922.

Production of power from fuel decreased steadily to the beginning of May (as in previous years) and then remained constant. Production of water power, however, increased sharply and reached a figure for May that is greater than for any previous month of record.

The Survey's report is based on returns from about 3,500 central stations and other power plants engaged in public service, including electric railways, each having a monthly output of not less than 10,000 kw.hr.

President Harding's Plan for Ending the Coal Strike

The proposition made last week by President Harding to the striking coal miners and the mine operators as a basis for settling the strike consisted of these four main points: That work be resumed at once, with wages remaining the same; that a commission of fifteen men be established; that the commission draft a temporary wage scale to last until March 1, 1923; and that the commission work toward permanent reform of the coal industry. The President phrased his proposal in these words:

Mine workers are to return to work on the scale of wages which expired last March 31, and mines now idle because of strike or suspended operation to resume activities, without interference with activities of mines now working. The 1922 scale to be effective until Aug. 10, 1922.

A Coal Commission to be created at once consisting of three members selected by the mine workers, three members selected by the mine operators and five members to be named by the President. All decisions by this committee shall be accepted as final.

This commission to determine, if possible, within thirty days from today for the miners on strike a temporary basic wage scale, which scale shall be effective until March 1, 1923. In event that the commission is unable to report its scale by August 10 it shall have power to direct continued work on the 1922 scale until the superseding scale is ready.

The commission shall investigate exhaustively every phase of the coal industry. It shall reveal every cost of production and transportation. The President will ask Congress to confer authority for the most thorough investigation, and make appropriations necessary to do such work. The commission shall make recommendations looking to the establishment and maintenance of industrial peace in the coal industry, the elimination of waste due to intermittency and instability, and suggest plans for a dependable fuel supply.

The President made no threat of drastic action in case of a refusal to accept his suggestions, but his proposal was looked upon by many as the Government's last word in its effort to bring about a settlement of the strike.

Public Utilities Well Supplied With Coal

That electrical and artificial gas public utilities had, on June 15. an average of fifty-three days' supply of coal on hand, is the report of F R. Wadleigh, chief of the newly organized coal division of the Department of Commerce, as the result of a canvass of public utility coal stocks that has recently been completed by the National Committee on Gas and Electric

Service under the immediate direction of Geo. H. Elliot. Mr. Wadleigh says further: "A great many utilities are receiving current supplies from non-union production, and on the basis of their current encroachment on stocks it seems that their stocks would last about twelve to fifteen weeks."

Brazilian Exposition and Engineering Congress

America will have an exposition in 1926 at Philadelphia, and France will have one in 1925 at Paris, but Brazil is completing preparations to open an exposition of its own, together with an International Engineering Congress, at Rio de Janeiro, Sept. 7 of this year. The occasion will be the celebration of the first centennial of Brazilian independence, Sept. 7 being the Brazilian Independence Day. The Congress will last from the 7th to the 30th, but the exposition will be kept open until March 31, 1923.

The Congress is being organized by the Club de Engenharia, of Rio de Janeiro, the leading engineering organization of Brazil, which has issued a formal invitation to *Ingeniería Internacional* (the McGraw-Hill paper printed in Spanish) to participate in the Congress, which is the first of its kind to be held in Latin-America. Invitations have also been sent to all engineering societies of the United States and Canada, and through them to the members of the societies.

It is expected that the principal subjects of discussion at the Congress will be: The Utilization of Fuel Resources, The Best Utilization of Water Power, Recent Advances in Irrigation Methods, The Elimination of Waste through the Standardization of Supplies for Agriculture and Industrial Purposes, Coal as a Factor in Industrial Development, Essentials of a National Railroad Policy, Inter-Continental Engineering Co-operation, Port Developments, Terminal Facilities, The Iron and Steel Industry.

The World's Largest Hydraulic Unit

Three hydraulic turbines that will produce 70,000 hp. each, to drive generators of 65,000-kva. capacity, are the record breaking units recently ordered by the Niagara Falls Power Company. In point of capacity, they will exceed the Queenston turbines by 15,000 hp., and will therefore be the largest hydraulic units in the world. These units are to be installed in an extension to Station No. 3 of the company (described in the June 6 issue) which is located on the American side, below the steel arch bridge, at Niagara Falls. The Allis-Chalmers Manufacturing Co. has received the contract for one of the combined hydro-electric units.

This hydraulic turbine will produce 70,000 hp. when operating under a head of 215 ft. and running at a speed of 107 r.p.m. The height of the unit from the bottom of the hydraucone chamber to the top of the generator is 86 ft. The power is produced by one runner weighing 86,000 lb. directly secured to a 35-in. diameter forged-steel shaft. Water is supplied to the turbine through a plate-steel circular-section spiral casing. Mounted immediately above the turbine, the generator will deliver 65,000 kva. at 13,000 volts, 25 cycles.

It is estimated that it will take about one year to construct this machine, and that the efficiency of the unit from water to busbar will be over 90 per cent. The design is similar in all respects to the 37,500-hp. Allis-Chalmers hydro-electric unit supplied some three years ago to the same company and described in detail in the Sept. 14, 1920, issue of *Power*.

The General Electric Co. has received the order for the other two generators, which will be driven by 70,000-hp. hydraulic turbines made by the William Cramp & Sons Ship and Engine Building Co., of Philadelphia. Each generator will weigh about 700 tons, and will be 35 ft. in diameter and 26 ft. high. It is interesting to note that the new generators are twice the capacity of the three 32,500-kva. generators now contained in Station No. 3, which at the time of their installation were considered the largest in existence.

Coming Conventions

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Des Moines, Ia., Sept. 11-16. Annual conventions and exhibitions of the State Associations scheduled as follows:

Michigan, at Kalamazoo, July 19-21; A. M. Adams, 1307 Stockbridge Ave., Kalamazoo, Mich.

Wisconsin, at Madison, July 26-28; C. Z. Wise, 204 South Carroll St., Madison.

Minnesota, at Minneapolis, Aug. 9-11; C. A. Nelsen, 800 22nd Ave., N. E., Minneapolis.

Iowa, at Des Moines, Sept. 10-11; Abner Davis, Room 16, Waterhouse Block, Cedar Rapids, Iowa.

Universal Craftsmen Council of Engineers; Thomas H. Jones, 33 Linden Ave., Cherrydale, Va. Annual convention and exhibition at Cleveland, Aug. 7-11.

International Union of Steam and Operating Engineers, Dave Evans, 6334 Yale Ave., Chicago, Ill. Biennial convention and exhibition at Minneapolis, Minn., Sept. 11.

Association of Iron and Steel Electrical Engineers, 1007 Empire Bldg., Pittsburgh, Pa. Annual convention and exhibition at Cleveland, Ohio, Sept. 11-16.

New Publications

Prime Movers Report—Report of the Prime Movers Committee, Technical National Section, National Electric Light Association. Published by the Association at 29 West 39th St., New York City. Paper; 8 x 11 in.; 346 pages. Price, to members, $3.50; to non-members, $7.

The lengthy report of the N.E.L.A. Prime Movers Committee is a rich mine of practical information on the economical operation and maintenance of stokers, boilers, turbines, engines and other main and auxiliary apparatus used in the production of power. There have been gathered together in the report the most important results of experiences in the handling of such apparatus in central stations throughout the country, together with statements from manufacturers describing their new apparatus and giving their ideas and experiences on the problems of the power plant. The scope of the work is wide, covering practically every important piece of equipment used in the power plant. The value and reliability of the data given are attested by the high standing of the 55 members of the Prime Movers Committee, of which H. P. Liversidge is chairman and C. F. Hirshfeld is vice-chairman.

Personals

A. G. Crocker has been appointed manager of the power division of the Detroit office of the Westinghouse company, and R. J. Cobban has been made branch manager of the Butte office.

Peter G. Rimmer, formerly district manager of the Ridgway Dynamo and Engine Co., is now associated with the Scranton Electric Construction Co., representing the General Electric Co. at Scranton, Pa.

Joseph Harrington has been retained in an advisory capacity by the Union Machine and Manufacturing Co., of Canton, Ohio, which has recently become the owner and manufacturer of the Harrington stoker.

William S. Hill, formerly manager of the Stuttgart Division of the Arkansas Light and Power Co., has joined the Missouri Water Power Co. as engineer on their water-power development near Lebanon, Mo.

John C. Parker, formerly head of the electrical department of the University of Michigan, is now the electrical engineer of the Brooklyn Edison Co., Brooklyn, N. Y., succeeding Mr. Sprong, who is now associated with the Atlantic Utilities Corporation, of New York City.

W. V. Giffer was recently appointed chief boiler inspector of the Industrial Board of Indiana after three years' service in the field. He is a veteran of the recent war, having spent over nineteen months in France as general foreman of the St. Nazaire shops, where as many as six completely assembled locomotives a week were turned out.

Arthur L. Rice, editor of *Power Plant Engineering*, has been elected vice-president of the American Society of Mechanical Engineers to fill the vacancy caused by the death of Louis E. Strothman until the regular election of officers is held at the annual meeting next December. Mr. Rice is a member of several other engineering societies and has been active in the Chicago Section of the A.S.M.E., having served as secretary and later as chairman.

Trade Catalogs

Synchronous Motors—Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin No. 1124, 20 pages, telling the story of the synchronous motor and its construction, and its use for improvement of power factor; well illustrated with interesting photographs.

Dommer Gas Calorimeter—Herman A. Holz, 17 Madison Ave., New York City. An 11-page booklet describing and setting forth the advantages of a self-contained gas calorimeter for finding the heating value of gases without the use of a gas meter, pressure regulater, barometer, thermometer, etc.

Portable Conveyors—Jeffrey Manufacturing Co., Columbus, Ohio. Bulletin No. 369, describing a new portable belt conveyor, driven either by electric motor or gasoline engine, for handling coal, coke, cinders, etc., with a capacity of from 20 to 50 tons per hour.

Regulating Boiler Feed Water—Northern Equipment Co., Erie, Pa. A 20-page booklet containing a reprint of an article on regulating boiler-feed water, and describing the construction, operation and advantages of the Copes regulator. A number of interesting charts are included to show the effect of the regulator upon the operation of a boiler.

Boiler Setting Cement—Jos. W. Hays Corporation, Michigan City, Ind. Short bulletin describing "Bestix," an asbestos boiler-setting cement designed particularly to prevent infiltration of air.

Steam Turbines—Terry Steam Turbine Co., Hartford, Conn. An attractive and highly instructive 40-page catalog on condensing and non-condensing steam turbines, containing a lot of good photographs and giving a very clear explanation of mixed-pressure operation and of related subjects.

Unaflow Engines—Chuse Engine and Manufacturing Co., Mattoon, Ill. Bulletin No. 8, 16 pages, describing the Chuse poppet-valve unaflow engine, which is built in sizes from 75 to 1,200 hp., and speeds from 257 to 120 r.p.m., designed particularly for direct connection to electric generators.

Fuel Prices

FUEL OIL

New York—July 13, Port Arthur light oil 22@25 deg. Baumé 4c. per gal.; 30@5 deg., 5c. per gal. f.o.b. Bayonne, N. J.

Chicago—June 28, for 24@26 deg. Baumé, $1.15 per bbl.; 21@36 deg., 3½c. per gal. in tank cars, f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—July 11, f.o.b. refinery, Pennsylvania, 36@40 deg., 5½c.; Kentucky fuel oil, 26@30 deg., 4½c. per gal. Gas oil, 32@34 deg., 3½c. per gal.; 36@38 deg., 3½c.; 38@40 deg., 3⅝c. Western, 24@30 deg., $1.35 per bbl.

Philadelphia—July 10, 26@28 deg. Baumé, Oklahoma, $1.05@$1.10 per bbl.; 30@34 deg., Oklahoma (group 3), 2⅞@3¼c. per gal.; 16@20 deg. Seaboard, $1.15@$1.25 per bbl.

Cincinnati—May 27, for 26@30 deg. Baumé, 5½c.; Diesel 32@24 deg., 5½c. per gal.; distillate 39@40 deg., 6c.

Cleveland—May 27, 26@30 deg. Baumé, 4¾c. per gal.

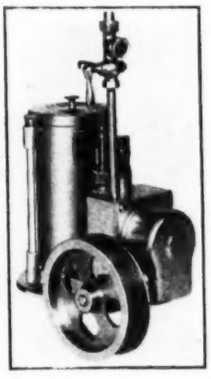
BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-rune bases, f.o.b. mines):

Coal	Market Quoting	July 3, 1922	July 10, 1922
Pool 1,	New York	$4.75–4.85	.....
Smokeless,	Columbus	3.35–3.50	$3.35–3.50
Clearfield,	Boston	6.10–6.25	3.25–3.75
Somerset,	Boston	3.35–3.60	3.50–3.75
Kanawha,	Columbus	3.25–3.50	3.25–3.50
Hocking,	Columbus	3.25–3.50	3.25–3.50
Pittsburgh No. 8	Cleveland	3.90–4.10	3.90–4.15
Franklin, Ill.,	Chicago	.....	.....
Central, Ill.,	Chicago	.....	.....
Ind. 4th Vein,	Chicago	.....	.....
West Ky.,	Louisville	4.25–4.50	4.50–5.25
Big Seam,	Birmingham	2.00–2.25	2.00–2.30
S. E. Ky.,	Louisville	3.50	3.50–3.85

Condensed-Clipping Index of Equipment

For quick reading and convenient filing. These products have not been described before in "Power."



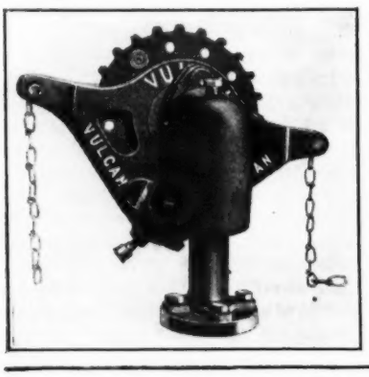
Lubricator, Automatic, Rotary Drive "Power," 1922.

Greene, Tweed & Co., 109 Duane St., New York City.

A new model of the Rochester automatic lubricator has been put on the market; it is operated by a pulley instead of a reciprocating arm, as in the standard model. The pulley drives through an inclosed worm and gear. Different reducing ratios may be obtained, the pulley may be on either side as required, and it may be run in either direction. The quantity of oil supplied is regulated by adjustment of the stroke of the plunger. The device is recommended for the lubrication of the cylinders, stuffing boxes, and important bearings of steam and oil engines, pumps, compressors, etc., or for important bearings of other machines.

Cleaner, Soot "Power," 1922.

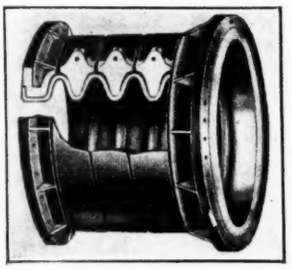
Vulcan Soot Cleaner Co., Du Bois, Pa.



The operating head of this cleaner has been redesigned to eliminate the human element in its operation. The company has found that incomplete results in a number of cases were due to the haste or carelessness of the operator, in that he swung the element around too fast or did not swing it far enough. The new head is therefore designed with a ratchet movement; the chain wheel can be turned only a short distance, then must be turned back, then ahead, etc., with a back-and-forth movement that eliminates the possibility of turning it too fast.

Joint, Expansion "Power," 1922.

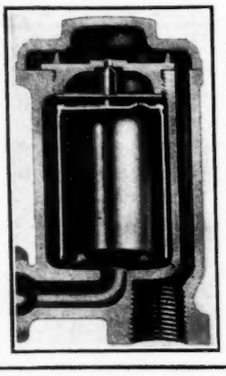
Badger Fire Extinguisher Co., 175 Portland St., Boston, Mass.



A joint for absorbing expansion in pipe lines. It is built for pressures up to 250 lb., in sizes from 1¼ to 20 in., and for an expansion of from 1 to 2 in. The joint consists of a single piece of seamless copper tubing with deep corrugations, fitted with iron or steel rings that allow a safe amount of expansion on each corrugation. American standard flanges are used up to 125 lb. pressure, extra-heavy flanges being provided in pressures between 125 and 250 lb. Joints in sizes above 20 in. are supplied on special order. Single corrugation joints are also made, primarily for exhaust work, as between turbine and condenser.

Trap, Radiator "Power," 1922.

Armstrong Machine Works, Three Rivers, Mich.



A radiator trap, for letting out air and water while preventing the escape of steam. It consists of four principal parts—the main body, a cap that closes it, the inverted bucket and a thermic strip that prevents the bucket from rising and closing the outlet until the trap becomes warm. The inlet is shown at the lower left; the outlet is through the cap at the top, and down and out through a port at the right. When the trap is full of water, the inverted bucket sinks, allowing the water to escape. Incoming steam, also, escapes at first when the trap is cold, but when the thermic strip above the bucket is heated, it bows upward, allowing the steam to raise the bucket by giving it buoyancy and thus closing the valve. Air escapes through the small vent in the top of the bucket. The trap is for use with low-pressure and vacuum systems where the differential pressure is not less than one-quarter pound.

For a permanent file of new and improved power-plant equipment, clip and paste on 3 x 5-in. cards. (Patented Aug. 20, 1918.)

New Plant Construction

PROPOSED WORK

Cal., Fall River Mills—The Fall River Mills Irrigation District, J. H. Creighton, Glenburn and S. McArthur, McAuthur, Trustees, plan constructing works for irrigation district, including canals, and 3 pumping plants. Engineer not selected.

Cal., Oakland—The Bd. Educ. will receive bids until Aug. 14 for 2 story vocational high school on Myrtle and Linden Sts., also will soon receive bids for 2 and 3 story high school on 19th Ave. and East 18th St. Estimated costs $385,000 and $700,000 respectively. C. W. Dickey, 2149 Broadway, Archt. Noted May 9.

Cal., Oakland—The Providence Hospital Assn., 26th St. and Broadway, is having plans prepared for hospital on Webster and Summit Sts. Estimated cost $700,000. Architect's name withheld.

Cal., San Francisco—The Bd. Public Works will receive bids until Aug. 9 for furnishing and delivering 13 6667 kva., 154 kv. star to 11 kv. delta, 60 cycle, single phase transformers, 13 station service transformers and accessories, electric benchboard and auxiliary switchboards complete with all equipment, four 20,000 kva. generating units with d.c. exciters, automatic voltage regulators, 1 motor generator exciter set, four 20,000 kva. transformer banks, two 60,000 kva., 154 kv. transmission lines and all associated and auxiliary station apparatus, blank panels shall be provided on bench board for controlling: 2 future 20,000 kva. generating units, 2 future transmission lines, for the Mocassin Creek power plant, Hetch Hetchy project contract No. 81. M. M. O'Shaughnessy, City Hall, Engr.

Cal., San Francisco—MacDonald & Couchot, Archts., 110 Sutter St., are receiving bids for 10 story hotel and 1 story store building on Sutter and Taylor Sts. for G. D. Smith, 735 Taylor St.

Cal., San Mateo—F. E. Webb, 16 East 41st St., New York, and Associates, are having sketches prepared for tourist hotel, club quarters, etc., at Coyote Point. Estimated cost $500,000. Willis Polk & Co., Hobart Bldg., San Francisco, Archts.

Cal., Templeton—The Union High School District, Trustees, and W. C. Smalling, Clk., will receive bids until July 22 for Deming hydro pneumatic water system No. 2018 with 1-1 hp. a.c. single phase cycle, 110-220 volt self-starting motor.

Cal., Turlock—Turlock and Modesto Irrigation Districts, plan to construct a joint transmission line from Don Pedro project to Keyes. P. Jones, Chf. Engr. for Modesto and R. V. Meikle for Turlock Dist. Noted June 20.

Conn., Devon (Milford P. O.)—The Connecticut Light & Power Co., 107 West Main St., plans to build a large power plant unit on the east side of the Housatonic River, here. Private plans.

Conn., New Britain—The Bd. Educ., A. D. Meredith, Secy., State House, Hartford, will soon award the contract for 1 and 2 story Normal school, also a boiler house, on Camp St. Estimated cost $700,000. Guilbert & Betelle, 546 Broad St., Newark, N. J., Archts., A. S. Kellogg, 89 Franklin St., Boston, Mass., Engr. Separate contract for steam heating and ventilating systems. Noted Apr. 25.

Conn., New Haven—The Bd. Educ. plans to build 3 story high school on Edgewood Ave. Estimated cost $300,000. C. S. Palmer, 114 Whitney Ave., Archt.

Conn., West Cornwall—The Connecticut Light & Power Co., 107 West Main St., Waterbury, plans to build a dam on the Housatonic River between here and Limerock, also a power station. Private plans.

Fla., Miami—The City Council will receive bids until July 26 for two centrifugal pumps, 2,000,000 gal. per day capacity, each, in connection with sewerage system at Miami Beach. Estimated cost $30,000. R. M. Davidson, Engr.

Fla., Orlando—W. F. Blackman and Associates plan to build an ice and cold storage plant. Estimated cost $50,000 to $100,000.

Ga., Dalton—The Bd. of School Comrs., F. Manly, Chn., will soon award the contract for 2 story 76 x 125 ft. high school, including steam heating system. J. J. Baldwin, Anderson, S. C., Archt.

Ill., Chicago—W. W. Ahlschlager, Archt., 60 East Huron St., plans a 12 story, 125 x 180 ft. athletic club, including steam heating system, on Lake Shore Drive. Estimated cost $2,000,000. Owners name withheld.

Ill., Chicago—Dubin & Eisenberg, Archts., 14 West Washington St., will soon receive bids for 6 story, 120 x 150 ft. apartment building, including steam heating system on Sheridan Rd. and Lunt Ave., for B. H. Rosenthal, c/o Archts. Estimated cost $560,000.

Ill., Chicago—Kramer & Schnadig, c/o Newhouse & Bernham, Archts., 4630 Prairie Ave., plans to build a 2 story, 125 x 125 ft. store, office and theatre building, including steam heating system, on 63d St. and Kedzie Ave. Estimated cost $400,000.

Ill., Chicago—The LeRue Popperfuss Hotel Co., c/o R. S. De Golyer, Archt., 7 South Dearborn St., will soon award the contract for 12 story, 102 x 134 ft. hotel, including steam heating system, on Pearson and Seneca Sts. Estimated cost $2,000,000.

Ill., Chicago—The H. L. Stevens & Co., Archts., 30 North Michigan Blvd., is preparing plans for 10 story, 100 x 143 ft. hotel, including steam heating system, on Sheridan Road, for the Juddson Hotel Co., c/o Archt. Estimated cost $1,250,000.

Ill., Waukegan—The Orpheum Theatre Co., 112 South State St., Chicago, is having plans prepared for 3 story, 75 x 200 ft. theatre on Water and Genesee Sts. Estimated cost $500,000. Rapp & Rapp, 190 North State St., Chicago, Archts.

Ia., Mason City—The city, C. J. DeLacy, Secy., will receive bids until Aug. 3 for horizontal steam surface condenser, exhaust steam feed water heater and steam-driven air compressor of 1,500 to 2,000 capacity. Estimated cost $25,000. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul, Minn., Engr. Noted May 2.

Kan., Kansas City—W. W. Borowski, 1211 Greeley St., is in the market for 22 hp., 4 cylinder, 4 cycle engine.

Kan., Wichita—The Miller Theatre, S. Chambers, Purch. Agt., North Market St., is in the market for a refrigeration cooling system. Estimated cost $50,000.

Mass., Monson—Ricketts & Shaw is having plans prepared for 40 x 40 ft. power plant. Estimated cost $25,000. Reeds & Thorpe, 60 Prospect St., Hartford, Conn., Engrs.

Mich., Detroit—The Bd. Educ., 1354 Broadway Ave., received bids for 2 story school building, including steam heating. Plenum system, on Brooklyn Ave., from F. H. Goddard, 2130 Franklin St., $295,500, G. Worswick, 410 Hodges Bldg., $298,400, Corrick Bros., 507 Owen Bldg., $299,878.

Mich., Detroit—The Ford Motor Co., Highland Park, plans to build 1 story, 245 x 1570 ft. addition to factory, including steam heating system, on Livernois Ave. A. Kahn, 1000 Marquette Bldg., Archt.

Mich., Detroit—The J. L. Hudson Co., 1201 Farmer St., plans to build a 10 story addition to mercantile building, including steam heating system, on Woodward Ave. Smith, Hinchman & Grylls, 710 Washington Arcade, Archts.

Mich., Port Huron—The Bd. Educ., plans to build 2 story junior high school, including steam heating system, on Erie St. Estimated cost $250,000. Van Leyer, Schilling, Keough & Reynolds, 3440 Cass Ave., Detroit, Archts.

Minn., Barnum—The city, A. D. Dathe, Clk., will soon award the contract for waterworks and distribution systems, including pumping machinery, etc. Estimated cost $21,800. Druar & Milinowski, 500 Globe Bldg., St. Paul, Engrs.

Minn., Duluth—F. A. Cokefair, Chn. Hospital Committee, 516 Providence Bldg., will receive bids until Sept. 30 for 4 story, 140 x 250 ft. hospital, including steam heating system, on Frost and 9th Aves. Estimated cost $750,000. R. G. Schmidt & Co., 154 West Rand St., Chicago, Ill., and German & Jenssen 411 Exchange Bldg., Archts. and Engrs.

Minn., Virginia—The Community Hotel Financing & Bldg. Co., 743 Plymouth Bldg., Minneapolis, is having plans prepared for 3 story hotel, including steam heating system. Estimated cost $300,000. C. W. Farnham, 1040 Lumber Exchange Bldg., Minneapolis, Archt.

Miss., Coffeeville—The city, F. L. Dye, Clk., will soon award the contract for machinery and equipment for proposed light and power plant.

Mo., Kansas City—J. J. Caldwell, 2645 Southwest Blvd., is in the market for 10 hp., 60 cycle motor.

Mo., Kansas City—Danciger Bros., A. Danciger, Purch. Agt., 308 West 6th St., is in the market for 24 hp. a.c. motor, 60 cycle, 3 phase, slow speed.

Neb., Lincoln—The W. A. Parvin Garage, 821 South 11th St., is in the market for 200 lb. pressure air compressor, 3 hp. motor attached, horizontal type. (Used.)

Nev., Reno—The County of Washoe, E. H. Beemer, Clk., will receive bids until July 29 for furnishing equipment for Isolation Hospital and installing a No. 110 Kewanee or smokeless firebox boiler in basement of courthouse. G. A. Ferris & Sons, Colonial Apts., Archts.

N. J., Atlantic City—Hotel Chelsea plans to build a 125 x 150 ft. addition to hotel, including steam heating system, on South Morris Ave. Estimated cost $3,000,000. Carrere & Hastings, 52 Vanderbilt Ave., New York, Archts.

N. Y., Brooklyn—W. S. Freezer & Machine Corp., 270 Union Ave., is in the market for one gas engine.

N. Y., Buffalo—The Bd. Educ., 1401 Telephone Bldg., will receive bids until July 26 for equipment for vocational school, including motor generator set complete, high speed, ball bearing, spindle sensitive drill, motor head engine lathe, 715 r.p.m., motor complete with rails and fitted with pulleys, 9 in. in diameter, 8 in. face.

N. Y., Buffalo—Clement & Weed will soon receive bids for 14 story office building on Main and Genessee Sts. Estimated cost $1,000,000. Architect not announced.

N. Y., Buffalo—W. J. Jackson, 218 Delaware Ave., plans to build 8 story store and office building on Delaware Ave. Estimated cost $500,000. Architect not announced.

N. Y., Central Islip—The State Hospital Commission, State Capitol, Albany, received bids for addition to cold storage plant here, construction work, from B. S. Raynor, Islip, $46,740, M. Kantrowitz, Market St., Albany, $53,800, refrigeration, Shipley Construction Co., Columbia & Warren Sts., $29,900, Mayer Ice Machine & Eng. Co., Jersey City, N. J., $31,600, American Carbonic Machine Co., 30 Church St., New York, $32,835.

N. Y., Cohoes—C. L. Cadle, Supt. Pub. Wks., State Capitol, Albany, received bids for Contract A-1 furnishing and delivering two hydraulic turbines with governor equipment for proposed power house at Crescent Dam, Crescent, from S. Morgan Smith Co., York, Pa., $92,957, The Wm. Cramp & Sons Ship & Engine Bldg. Co., Phila., Pa., $124,000, The Wellman Seavor-Morgan Co., Cleveland, Ohio, $126,000, Contract A-2 for furnishing water wheel driven generators and other electrical equipment in the proposed power house at Crescent Dam here, from General Electric Co., Schenectady, water wheel driven generator units, 90 r.p.m.—1,800,000 WR2, $100,694. 90 r.p.m.—2,666,666 WR2, $105,824. 90 r.p.m.—2,000,000 WR2, $102,420. 105.9 r.p.m.—1,800,000 WR2, $100,200. (WR2 refers to the flywheel effect of the generator in foot square pounds.)

N. Y., Elmira—The Bd. Educ., received bids for 3 story junior and senior high school on the south side from Felton Constr. Co., Buffalo, $385,184, Tifft Constr. Co., Iroquois Bdg., Buffalo, $470,422, Drummond-Miller Co., 4500 Euclid Ave., Cleveland, $427,380, heating and ventilating, Globe Automatic Sprinkler Co., 2035 Washington St., Phila., Pa., $53,700.

N. Y., New York—The Bd. Educ., 500 Park Ave., is having plans prepared for 5 story P. S. No. 63, including steam heating system, on Franklin Ave. and 168th St.

Estimated cost $500,000. C. B. J. Snyder, Concord St., Brooklyn, Archt. and Engr. Noted May 9.

N. Y., New York—The Bd. of Purchase, Room 526, Municipal Bldg., will receive bids until July 21 for furnishing and delivering gasoline driven, portable air compressors to the Department of Plant and Structures.

N. Y., New York—A. Bricken, c/o Gronenberg & Leuchtag, Archts. and Engrs., 450 4th Ave., are having plans prepared for 12 story apartment building, including steam heating system, on Lexington Ave. and 74th St. Estimated cost $750,000. Work will be done by separate contracts under supervision of architects.

N. Y., New York—The New York Edison Co., 130 East 15th St., is having plans prepared for 3 story, 46 x 125 ft. transformer station at 12 Stone St. Estimated cost $90,000. W. Whitehill, 709 6th Ave., Archt. and Engr.

N. Y., New York—The Pyramid Iron Products Corp., 2 Rector St., is in the market for Corliss engine, 16 ft. dia. wheel, 32 in. face and 12 in. bore.

N. Y., Solvay—The School Board will receive bids about August for high school and Boyd school. Estimated cost $400,000 and $80,000 respectively. Former bids rejected. M. L. King, Snow Bldg., Syracuse, Archt.

N. C., Cumnock—The Rocky River Power Co. is in the market for equipment for proposed hydro electric power plant.

N. C., Mebane—The White Furniture Co., W. E. White, Pres., is in the market for electrical equipment and machinery to operate plant now steam driven.

N. C., Rocky Mount—Munn & Griffon Co., is in the market for refrigeration, cold storage machinery and equipment.

N. C., Wilmington—The city plans remodeling filteration plant and pumping station, new piping to Toomey's Creek, 48 in. main running under Cape Fear River. Estimated cost $400,000. Carolina Engineering Co., Engrs.

Ohio, Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., received bids for 3 story addition to high school on West 93d St. and Willard Ave. from Drummond-Miller Co., 4500 Euclid Ave., $652,000., Wm. Moore Co., 1276 West 4th St., $695,990, steam heating system, Warden & Leese, 2450 Prospect Ave., $130,697. W. R. McCornack, Archt. Noted June 20.

Okla., Oklahoma City—The city, C. F. Semmelbeck, Clk., will receive bids until Aug. 2 for water filtration plant, including aerator, mixing chamber, 2 clear water reservoirs, head house and 8 two million gal. filter units complete with all equipment. A. S. Holway, Engr. Water Dept.

Okla., Redrock—The city has had plans prepared for transmission line. Estimated cost $25,000. J. D. Bouford & Co., Enid, Engrs.

Pa., Phila.—The Mutual Trust Co., Bourse Bldg., will soon receive bids for 12 story bank and office building on 4th and East Market St. Estimated cost $2,000,000. Heacock & Haakenson, Bailey Bldg., Archts.

Pa., Sunbury—The Sunbury Water Co. plans to build a 50 x 50 ft. boiler house. Engineer not announced. Quotations wanted on equipment.

S. C., Darlington—The Carolina Ice & Packing Co. is in the market for a 75 hp. crude oil engine.

S. D., Murdo—The city will receive bids until July 31 for waterworks system, including pumping station, elevated tank, earth dam and 12,740 ft. of water mains. Dakota Engineering Co., Mitchell, Engrs.

Tenn., Nashville—The State of Tennessee, Central Insane Hospital, L. Pope, Dir. Administration, Capitol Annex, will soon award the contract for additions to heating plant on Murfreesboro Road, including high and low pressure piping, feeders, vacuum pumps and heating equipment to the various buildings from central plant. Estimated cost $15,000.

Va., Hampton Roads—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until July 26 for coal and ash handling equipment, here. Spec. 4667, also heating plant, Spec. 4629. Noted June 13.

Va., Newport—The Page Power Co., A. A. Roudabush, Secy., Shenandoah, plans hydro electric power plant to develop 1,800 hp., on the Shenandoah River here; will soon receive bids for construction of power house. Estimated cost $100,000. Contract for dam has recently been awarded to the Ambursen Constr. Co., Grand Central Terminal, New York.

Va., Stuart—W. H. Clark is in the market for 50 kva. alternator complete, 75 kva. alternator with exciter and switchboard and 40 hp. crude oil engine.

Wis., Baraboo—The G. M. Cartheu & Sons Co., plans to build a hydro electric plant, including 50 kw. generator and switchboard, also a private water system. Estimated cost $45,000. Architect not seected.

Wis., Dodgeville—The city, J. B. Lewis, Clk., plans improvements to pumping station, furnishing and laying watermains in Merrimac, West Division, Washington and 11th Sts. Estimated cost $25,000. Engineer not selected.

Wis., Ellis Junction (Crivitz P. O.)—The North East Power Co., 559 Marshall St., Milwaukee, will soon receive bids for equipment, etc., for hydro electric power plant, here, including three 4 x 4 ft. steel sluice gates and hoists, and 15-ton hand crane. Mead & Seaster, State Journal Bldg., Madison, Engrs.

Wis., Marshfield—P. Hagen, Route 1, is in the market for air compressor, gas storage tank, etc.

Wis., Milwaukee—The S. S. Cyril & Methody Congregation, 1110 Milwaukee Ave., will soon award the contract for 48 x 50 central heating plant, including two 54 in. boilers and pumps, on 10th Ave. and Hayes St. Estimated cost $40,000. Gurda & Gurda, 2nd Ave. and Mitchell St., Archts. and Engrs.

Wis., Taylor—The city, H. T. Nepernd, Clk., is having plans prepared for pumping station, including equipment. Estimated cost $60,000. W. E. Bennett, 418 Batawean Bank Bldg., La Crosse, Archt., W. S. Woods, La Crosse, Engr.

N. B., St. John—The Dept. Public Works, R. C. Desrochers, Secy. Ottawa, Ont., will receive bids until July 25 for steam boiler in the Savings Bank Bldg., here.

N. S., Canso—The Dept. Public Works, R. C. Desrochers, Secy., Ottawa, Ont., will receive bids until July 25 for hot water boiler and additional radiation for the Post Office here.

N. S., Yarmouth—The Yarmouth Light & Power Co. is in the market for equipment for proposed hydro electric power plant.

Ont., Alvinston—The city council, c/o R. Rillett, plans to build a pump house and install electrically driven pumps. Engineer not selected. Prices wanted on equipment.

Ont., Etobicoke—The township, S. Barrett, Clk., Islington, has had plans prepared and will soon receive bids for waterworks system in Area 3, consisting of about 19,400 ft. 6 and 8 in. watermain with valves, hydrants, meters, electrical driven centrifugal pumps and pump house. Estimated cost $60,000. F. Barber, 40 Jarvis St., Toronto, Engr.

Ont., Petrolea—The Peninsula Sugar Co., F. H. Hubbard, Genl. Mgr., is having plans prepared for a 175 x 225 ft. power house in connection with the proposed sugar refinery. Prices wanted on steam boilers and complete equipment for sugar refinery, having capacity of 600 tons per day. A Schoen, Archt., Honolulu Iron Wks., 8047 Hamilton Blvd., Detroit, Mich., Engrs. Noted Dec. 27, 1921.

Mexico, Coahuila—The American Smelting & Refining Co., 120 Broadway, New York, plans to build a smelting and refining plant here. Estimated cost $7,000,000. Work to be done by separate contracts under supervision of owner.

CONTRACTS AWARDED.

Cal., Sacramento—The California State Life Insurance Co., Forum Bldg., has awarded the contract for 10 story, 100 x 100 ft. store and office building, on 10th and J. Sts., to the Lindgren Co., Monadnock Bldg., San Francisco, about $1,000,000. Noted July 11.

Col., Denver—The T. M. Patterson Estate, Patterson Bldg., has awarded the contract for 10 story, 100 x 125 ft. office building on 17th and Welton Sts. to A. Olson, Bank Bldg., $334,000. Steam heating system will be installed. Noted Apr. 11.

Conn., Newington—The Connecticut Children's Aid Society, 904 Main St., Hartford, has awarded the contract for group of buildings, here, for the Newington Home for Crippled Children, to the Bartlett-Brainerd Co., 252 Asylum St., Hartford, heating and ventilating to W. B. Carson, 226 Sargent St., Hartford. Estimated cost $300,000. Noted Dec. 20, 1921.

Conn., New Haven—Yale University, J. R. Angell, Pres., has awarded the contracts for 3 story, 100 x 150 ft. forestry school on Prospect St. to the Casper Ranger Constr. Co., 20 Bond St., Holyoke, and a 3 story medicine building to be known as "Stirling Hall of Medicine," on Cedar and Broad Sts., to the Thompson-Starrett Co., 51 Wall St., New York. Estimated costs $300,000 and $1,320,000 respectively. Steam heating and ventilating systems will be installed.

D. C., Wash.—The W. F. Brenizer Co., 101 New York Ave. N. E., has been awarded the contract for hydroelectric power plant on Water St., $50,000. Owners name withheld.

D. C., Wash.—A. E. Walker, Southern Bldg., has awarded the contract for 8 and 11 story, 140 x 153 x 455 ft. hotel to the Longacre Engineering & Constr. Co., 46th St. and 4th Ave., New York. Estimated cost $5,000,000.. Noted May 2.

Ill., Chicago—The Natures Rival Co., 306 South Franklin St., has awarded the contract for a 3 story, 133 x 166 ft. factory on Hermitage Ave. and Irving Park Blvd. to the Salomon-Waterton Co., 230 East Ohio St. Estimated cost $180,000. Steam heating system will be installed.

Ill., Chicago Heights—C. H. Thomas, c/o Cannedy-Otto Mfg. Co., East End Ave., has awarded the contract for 6 story, 70 x 122 ft. store and hotel building on 1651 Halsted St., to the Chicago Heights Constr. Co., 1533 West End Ave. Estimated cost $250,000. Steam heating system will be installed.

Mass., Fitchburg—The School Dept. has awarded the contract for 3 story school building on Academy and Elm Sts. to C. H. Cunningham & Sons Co., 23 Central Ave., Lynn. Estimated cost $400,000. Steam heating and ventilating systems will be installed. Noted Nov. 15, 1921.

Mass., Springfield — I. Richmond has awarded the contract for 4 story store, office and apartment building on Main and Ferry Sts. to Meyer Construction Co., 318 Main St. Estimated cost $250,000. Steam heating system will be installed.

Mo., Jefferson Barracks—The Treas. Dept., J. A. Wetmore, Superv. Archt., Wash., D. C., has awarded the contract for mechanical equipment for the U. S. Veterans' Hospital here, to S. Faith & Co., 2427 Pennsylvania Ave., Phila., Pa., $311,000. Noted July 11.

N. J., Bordentown—The Commissioner of Educ. has awarded the contract for waterworks distribution system to J. R. Proctor, Bayonne, $6,286.40, tank tower and pump house to the Chicago Bridge & Iron Works, 30 Church St., New York, $6,450.

N. Y., Brooklyn—P. Ritzheimer, 122 Amity St., has awarded the contract for 5 story stores and apartment building on Livingston St. to M. L. & G. H. O'Shea, 29 Broadway, New York. Estimated cost $250,000.

N. Y., Retsof—The Retsof Mining Co., has awarded the contract for a machine shop to J. W. Cowper Co., Inc., Fidelity Bldg., Buffalo, $225,000.

N. C., Hendersonville—The Bd. Water Comrs., C. E. Brooks, Chn., has awarded the contract for the construction of a reservoir and 15 mi. of pipe line connecting intake at water shed to, Wilson & Kelly, Asheville, $181,000. Noted June 6.

Ohio, Cleveland—The Wilberite Roofing Co., 3700 Brook Park Rd., has awarded the contract for 35 x 130 ft. heating house to the VanDorn Iron Works Co., 2685 East 79th St. Estimated cost $40,000.

Ohio, Conneaut—The Bd. Educ. has awarded the contract for 1 story, 250 x 300 ft. junior high school on Mill St. to H. C. Miller, Erie, Pa. Estimated cost $300,000. Noted May 23.

Wis., Racine—The Wisconsin Gas & Electric Co., 305 6th St., has awarded the contract for 2 story, 50 x 60 ft. public utilities building, including equipment to the Worden Allen Co., Pt. Washington Road, Milwaukee. Estimated cost $50,000.

Bahama, Nassau—The Munson Steamship Line, Munson Bldg., 67 Wall St., New York, has awarded the contract for hotel here, to Purdy & Henderson, 47 East 17th St., New York. Estimated cost $1,000,000.